JANUARY 1979

- 10-GHz transceiver 26
- transmit/receive relay 46
- 5-amp power supply 50
- anodizing aluminum 62
- CMOS keyer 70

two-meter frequency synthesizer

$2.00
This amazing pocket sized radio represents the year's biggest breakthrough in 2-meter communications. Other units that are larger, heavier and are similarly priced can offer only 6 channels. The SYNCOM'S price includes the battery pack, charger, and a telescoping antenna. But, far more important is the 800 channels offered by the S1.

The optional touch tone pad shown in the illustration adds greatly to its convenience and we have available a 30 watt solid state power amplifier designed to give the SYNCOM S-1 the flexibility of operating as a mobile and base station as well.

**SPECIFICATIONS**

- **Frequency Coverage:** 144 to 148 MHz
- **Channel Spacing:** Receive every 5 kHz transmit simplex or -600 kHz
- **Power Requirements:** 9.6 VDC
- **Current Drain:** 17 ma-standby 400 ma-transmit
- **Batteries:** Ni-cad battery pack included
- **Antenna Impedance:** 50 ohms
- **Dimensions:** 40 mm x 62 mm x 165 mm (1.6" x 2.5" x 6.5")
- **RF Output:** Better than 1.5 watts
- **Sensitivity:** Better than .5 microvolts

**SUPPLIED ACCESSORIES**

- Telescoping whip antenna, ni-cad battery pack, charger.
- OPTIONAL ACCESSORIES
  - Touch tone pad, tone burst generator, CTCSS sub-audible tone chips
  - Rubber flex antenna

**Price:** $349.00 (or with touch tone pad...$399.00)

Tempo also offers a complete line of solid state power amplifiers, pocket receivers, the FMH-2, G & 42 portables, the VHF/ONE PLUS mobile transceiver, and the FMT-2 & FMT-42 remote control mobile transceiver. All available from Tempo dealers throughout the U.S.

Calls or write for full information.

11240 W. Olympic Blvd., Los Angeles, Calif. 90064 213/477-6761
931 N. Euclid, Anaheim, Calif. 92801 714/772-9200
Butler, Missouri 64730 816/679-3127

Prices subject to change without notice.
The revolutionary Swan 100 MX: 100% new, 100% solid state, 100% portable from home station to mobile!

Introducing a superb "get up and go" transceiver, superbly designed for 100% mobility and control, as only new Swan space-age technology could do it!

**100% solid state 100 MX:** the compact HF unit you can take seriously — anywhere you choose to operate.

At home, set into Swan's unique new style-coordinated station, with matching antenna tuner and power supply.

Or on the road — it's easy to relocate 100 MX. Instantly. Just two simple connections on the back panel: snap out, snap in... and run!

**100% improved audio quality:** home or mobile, transmit or receive. 100 MX electronics cut through SSB sound barriers — producing a natural clarity reported comparable to AM!

Your most-wanted extras, 100% built-in: like noise blanker and VOX. Like a preselector to optimize signals. Like a real RF GAIN control, and CW sidetone.

Swan includes the RIT control (±1.5 kHz) you'd like too. Plus, for stability, a permability tuned oscillator with 1Kc readout.

A powerful package, delivering a minimum 100 watts PEP output on all bands, 10-80 meters.

Setting a 100% new state of art: 100 MX and our matched-station units. Ready for check out today at your Swan dealer, the first major breakthrough in Swan's new program dedicated to changing the face — and performance — of ham equipment 100%...inside and out!

---

Available only through authorized Swan dealers.

Circle No. 79 on Reader Service Card
This NEW MFJ Versa Tuner II... has SWR and dual range wattmeter, antenna switch, efficient airwound inductor, built in balun. Up to 300 watts RF output. Matches everything from 1.8 thru 30 MHz: dipoles, inverted vees, random wires, verticals, mobile whips, beams, balanced lines, coax lines.

**MFJ LOWER PRICES!**

**NEW 300 WATT MFJ VERSA TUNER II’S: SELECT FEATURES YOU NEED.**

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>MFJ-945</td>
<td>SWR and dual range wattmeter</td>
<td>$69.95</td>
</tr>
<tr>
<td>MFJ-944</td>
<td>6 position antenna switch</td>
<td>$69.95</td>
</tr>
<tr>
<td>MFJ-943</td>
<td>Matches almost anything from 1.8 thru 30 MHz</td>
<td>$59.95</td>
</tr>
<tr>
<td>MFJ-901</td>
<td>VERSA TUNER MATCHES ANYTHING, 1.8 THRU 30 MHZ, NEW LOWER PRICE</td>
<td>$49.95</td>
</tr>
<tr>
<td>MFJ-900</td>
<td>ECONO TUNER MATCHES COAX LINES/RANDOM WIRES, NEW LOWER PRICE</td>
<td>$39.95</td>
</tr>
<tr>
<td>MFJ-16010</td>
<td>RANDOM WIRE TUNER FOR LONG WIRES, NEW LOWER PRICE</td>
<td>$29.95</td>
</tr>
</tbody>
</table>

**ULTRA COMPACT 200 WATT VERSA TUNERS FOR ALL YOUR NEEDS.**

- MFJ-901 VERSA TUNER MATCHES ANYTHING, 1.8 THRU 30 MHZ, NEW LOWER PRICE: $49.95
- MFJ-900 ECONO TUNER MATCHES COAX LINES/RANDOM WIRES, NEW LOWER PRICE: $39.95
- MFJ-16010 RANDOM WIRE TUNER FOR LONG WIRES, NEW LOWER PRICE: $29.95

For Orders Call toll-free 800-647-1800.

Order any product from MFJ and try it. If not delighted, return within 30 days for a prompt refund (less shipping).

Order today. Money back if not delighted. One year unconditional guarantee. Add $2.00 shipping/handling.

Order By Mail or Call TOLL FREE 800-647-1800 and Charge It On

MFJ ENTERPRISES, INC.

P. O. BOX 494
MISSISSIPPI STATE, MISSISSIPPI 39762

More Details? CHECK — OFF Page 118
JANUARY 1979
volume 12, number 1

T. H. Tenney, Jr., W1NLB
publisher
James R. Fisk, W1HR
editor-in-chief

editorial staff
Martin Hartl, W1CHO
administrative editor
Charles J. Carroll, K1XAK
Patricia A. Hawes, W1AKWM
Alfred Wilson, W1NRF
assistant editors
Thomas F. McMullen, Jr., W1SL
Joseph J. Schroeder, W1SSK
associate editors
Wayne T. Pierce, K3SUW
cover

publishing staff
C. Edward Buffington, W8TAMU
assistant publisher
Fred D. Muller, Jr., W1NUSO
advertising manager
James R. Gray, W1XU
assistant advertising manager
James R. Wales
art director
Susan Shorrock
circulation manager

ham radio magazine
is published monthly by
Communications Technology, Inc.
Greenville, New Hampshire 03048
Telephone: (603) 878-1441
Address all editorial and
advertising correspondence to:
Greenville, New Hampshire 03048

subscription rates
United States: one year, $18.00
two years, $36.00; three years, $54.00
Canada: one year, $19.00
two years, $38.00; three years, $57.00
Europe, Japan, Africa, and
Europe, Japan, Africa: one year, $25.00
Other Countries (via Surface Mail):
one year, $36.00
All subscription orders payable in
United States funds, please

foreign subscription agents
Foreign subscription agents are
listed on page 101

Microfiche copies
are available from
University Microfilms, International
Ann Arbor, Michigan 48106
Order publication number: 3078
Cassette copies of selected articles
from ham radio are available to the
blind and physically handicapped
from Recorded Periodicals
319 Wabun Street, 8th Floor
Philadelphia, Pennsylvania 19107
Copyright 1979 by
Communications Technology, Inc.
Title registered at U.S. Patent Office
Second-class postage
paid at Greenville, N.H. 03048
and at additional mailing offices
Publication number 203346

Subscription inquiries and changes of
address should be directed to ham radio
magazine, Subscription Processing Center
Box 711, Whitinsville, Massachusetts 01088
Please include address label from most
recent issue if possible
Postmaster send Form 3579 to Box 711
Whitinsville, Massachusetts 01088

10 two-meter synthesizer
R. B. Fanning, K4VB
Gary Grantland, WA4GJT

20 measuring FM deviation
Raymond Isenson, N6UE

26 10-GHz Gunnplexer transceiver
James R. Fisk, W1HR

46 fast and quiet
transmit/receive
relay
Nicholas Lefor, W1DB

50 adjustable 5-ampere
power supply
James S. Robbins, N1JR

56 Ham-III digital readout
N. Douglas Grant, K1DG

62 anodizing aluminum
David W. Hembling, VE7DKR

70 CMOS keyer
Urs Hadorn, HB9ABO

76 digital techniques:
basic rules and gates
Leonard Anderson

4 a second look
118 advertisers index
104 coming events
76 digital techniques
101 flea market
As the editor I would like to think that our articles have more effect on you, the reader, than anything else; if not the most immediate effect, certainly the longest lasting. To be completely realistic, however, the one department which has the greatest impact on readers is circulation. If your issue is mangled by the Postal Service, or is late in arriving, or doesn’t come at all, little time is wasted in letting our Circulation Manager know about it! I would hope that our response is just as immediate.

In the magazine business the word “fulfillment” is used to describe the internal business procedures which ensure that you get your mailed copy each and every month of your paid subscription. All magazines use a computer for this task, and we’re no different. In the past all subscription orders were keypunched here in Greenville, and the punched cards were sent on to a computer house in Boston which filed the information on magnetic tape in zip code order. That two-step procedure has worked well for a number of years, but the growth of *Ham Radio* and the introduction of our sister publication, *Ham Radio Horizons*, has begun to strain the system. To both reduce errors and improve service to our subscribers, we recently contracted with a professional magazine circulation fulfillment service to do the entire task. That means that the subscription information must be transferred from one computer to another.

If this were a perfect world the changeover would go without a hitch, but Murphy’s Law being what it is, there almost certainly will be some mistakes and garbled digits. We have instituted every safeguard we have available, but when you are faced with the humongous task of transferring nearly 50,000 names, callsigns, addresses, and subscription expiration dates, a few errors are inevitable. As the old saying goes, “Computers are not perfect — they’re only as smart as the data given to them!”

We have been laying the groundwork for this changeover for several months, so we don’t foresee any major problems. However, if your address label is garbled in the data transfer, please write to Ham Radio, Subscription Fulfillment Service, Post Office Box 711, Whitinsville, Massachusetts 01588. A correction will be made just as quickly as possible.

Although all subscription renewals, changes of address, and the like are to be mailed directly to our fulfillment service in Whitinsville, all correspondence to our editors or advertising department must be sent to our offices in Greenville. In the past, when readers have written to us about a subscription matter, they have often taken that opportunity to pose a question to our staff, or to comment on one of our previous articles. Such comments and questions are immensely useful as we plan future material for the magazine, but in the future such questions and comments should be separated from subscription matter and mailed directly to Greenville. Otherwise our staff won’t have the benefit of your suggestions.

If you have an occasion to write to our fulfillment service in Whitinsville, please be patient (for fastest service, be sure to include the mailing label). Just remember that the computer does its work several weeks before the magazine goes into the mail, so there is considerable lead time involved (up to six weeks). This presents a problem for us, too, because we won’t know a mistake has been made until you tell us about it, and we won’t be certain the problem has been corrected until the computer prints the address labels for the next issue. However, with patience and understanding from you, our readers, the task will go much more smoothly. Thank you for your help.

Jim Fisk, W1HR  
editor-in-chief
OSCAR the easy way!
WITH ICOM'S TRANSPORTABLE SIDEBANDS SIDE BY SIDE

The excitement and pride of operating through the OSCAR series of satellites is now totally transportable with ICOM's new IC-202S and IC-402. These are the world's only SSB portables, they both operate USB and LSB, and together they form an efficient, compact ground station that makes OSCAR communications much less complicated and much more fun.

Your OSCAR station can be quickly set up in any suitable location, and your two SSB portables will perform in tandem. Just use the 202S as the uplink (transceiver) for OSCAR VIII, mode "J" and as the downlink (receiver) for OSCAR VII, mode "B"; and tune the 402 to the complimentary channels. * Space Age radio has never been simpler.

Get into the excitement of satellite communications with the IC-202S and the IC-402, ICOM's high quality transportable sidebands.

*Crystals for this configuration are optional at extra cost.

All ICOM radios significantly exceed FCC specifications limiting spurious emissions.

Specifications are subject to change without notice.
Dear HR:

The suggestions by Robert Heider, W0EJO, in a different form of standard capacitor ("Bandspreading Techniques," February 1977) are deserving of some comment.

The technique of using a guard for accurate calibration is a good one, but it must be used with care. The following points apply:

1. Careful examination of the referenced article’s fig. 6 will show the variable insulated from the case and thus guarded if the case ground is used.

2. Guard circuits must be used with bridges designed for that purpose (see, for example, Electronic Measurement by Terman and Pettit, McGraw-Hill, 1953, pages 102, 103).

3. Guard circuits used with "ordinary" bridges, Q Meters, etc., will simply include the coaxial cable capacitance. In this case it would be better to use two coax cables, one on each capacitor terminal, in order to halve the stray capacitance. Cables should remain in place for resonating with small values of C, since they contribute around 10 to 20 pF shunt.

Any sort of coax at high frequencies (about 1 MHz or above) will begin to show transmission line effects. A couple of feet of coax at 30 MHz will change calibration at the low end of the C range, compared with measurements made at 3 MHz. The series inductance addition was implied when the article suggested "heavy wire and short lengths."

It’s surprising that even pros and old timers forget inductance of connection. Small inductance of leads makes the original noise bridge wideband. The largest stray inductance in the Hart bridge is the potentiometer arm connection, physically variable due to mechanical rotation. The arm is effectively balanced to ground on both sides of the bridge into the vhf region.

Leonard H. Anderson
Sun Valley, California

Dear HR:

After reading the September issue of ham radio, I feel the urge to write. That one issue paid for the whole year’s subscription! The article by W7VK on CATV cable fittings was a godsend to me — I’ve had twelve 1/2-inch-cable to SO-239 fittings on order for five months, at $7.50 each. I called them up and said send my money back.

The article by KlXX of your staff gave me the “big answer” for matching 75-ohm hardline. Thanks guys!

By the way, when preparing hardline for use with fittings that terminate in a type N female, you must file the end of the center conductor into a rounded bullet shape, because the square end will spread and break the female pin on the cable side of the fitting. When buying male type-N connectors, be advised that the Amphenol #82-61 is a 50-ohm connector, and the center pin will break the female pin in a 70-ohm hardline fitting. For the 70-ohm connector the Amphenol part number is 82-84, and, apparently they are not a stock item, at least around here. The foregoing tips cost me $22.50 to learn. Pass the word, and save others some money.

Thanks again for a great magazine, and if you would like some hardline, look me up. I’ve got a bunch!

Don Ryan, WB4NND
Virginia Beach, Virginia

Dear HR:

The article in the August issue, "High-Frequency Resolution for an HF Synthesizer," describes a principle which is used in the Collins 651S1 receiver for which Collins Radio has a patent. While this system is apparently very attractive at first glance, it has the following disadvantages:

1. Because of the frequency selection, a large number of birdies are present if filtering is inadequate.

2. The theoretical high-speed locking is degraded because of the algebraic logic. This slows down the synthesizer so much that it can’t be used efficiently for search operation. In the 651S1 receiver Collins engineers used an out-of-lock detector which mutes the receiver for virtually all tuning.

Finally, I would like to point out that my company holds the patent for the combination up/down counter with optical shaft encoder which was suggested for frequency synthesizer control (patent 97780, issued July 13, 1962).

Ulrich L. Rohde, DJ2LR
Rohde & Schwarz Sales Company
Fairfield, New Jersey
Kenwood's TR-7600 with optional RM-76 Microprocessor Control Unit offers a new dimension in channel memory and scanning capability.

...and, it's a combination that's hard to beat if you're looking for optimum versatility in a 2-meter FM transceiver. Together, the TR-7600 and RM-76 offer you the following:

**TR-7600 (only)**
- Memory channel...with simplex or repeater (plus or minus 600 kHz transmitter offset) operation.
- Mode switch for operating simplex or for switching the transmit frequency up or down...or for switching the transmitter to the frequency you have stored in the TR-7600's memory (while the receiver remains on the frequency you have selected with the dual knobs).
- Select any 2-meter frequency.
- Even without the optional RM-76, the TR-7600 gives you full 4-MHz coverage (144.000-147.995 MHz) on 2 meters; 800 channels; dual concentric knobs for fast frequency change (100 kHz and 10-kHz steps); 5-kHz offset switch, and MHz selector switch...for desired band (144, 145, 146, or 147 MHz).
- Digital frequency display (large, bright, orange LEDs).
- UNLOCK indicator...an LED that indicates transceiver protection when the frequency selector switches are improperly positioned or the PLL has malfunctioned.
- 10 watts RF output (switchable to 1 watt low power).

**TR-7600 WITH RM-76**
- Store frequencies in six memories.
- Scan all memory channels.
- Automatically scan up the band in 5 kHz steps.
- Manually scan up or down in 5-kHz steps.
- Set lower and upper scan frequency limits.
- Reset scan to 144 MHz.
- Stop scan (with HOLD button).
- Cancel scan (for transmitting).
- Scan for busy or open channel.
- Select repeater mode (simplex plus transmit frequency offset, minus offset, or one memory transmit frequency).
- Select transmit offset (±00 kHz/±1 MHz).
- Operate on MARS (143.95 MHz simplex only).
- Display indicates frequency (even while scanning) and functions (such as auto-scan, lower scan frequency limit, upper scan limit, error, and call channel).

See the exciting new TR-7600 and optional RM-76 now at any Authorized KENWOOD Dealer!

Subject to FCC approval.

TRIO-KENWOOD COMMUNICATIONS INC.
1111 WEST WALNUT/COMPTON, CA 90220
RUSSIA'S "RS" SATELLITES ARE UP and operating after a successful late October launch. Simultaneous beacon signals at about 29.400 MHz have been copied from both satellites. The uplink is 145.88-145.92 MHz with a 29.36-29.40 MHz output. The orbit of the RS satellites is considerably higher than that of any of the OSCARs, about 1050 miles. This should increase range 300-400 miles, with passes about three or four minutes longer than those of OSCAR 7. The orbital period is just over 120 minutes and its equatorial inclination about 83°, resulting in an orbit-to-orbit increment of just over 30°. Saturdays and Sundays will be the only days open for general use, with Wednesdays "educational days" and the rest of the week for scientific work. There is suspicion that RS's general use and educational days are Moscow time which is three hours ahead of GMT.

Daily RS News Bulletin, first in Russian (phone and CW) and then in English (CW only), are being sent on 7060 kHz at 0900Z by satellite command station RS3A. Radio Moscow broadcasts RS satellite news in English on 7165 kHz at 0130Z Sunday (Saturday evening, U.S. time).

REVELATIONS THAT AMATEUR RADIO was a principal communications tool of the People's Temple have heightened Amateur sensitivity to abuses of the bands. FBI agents, concerned about possible violent aftermaths of the carnage in Guyana, have been talking to a number of Amateurs who had worked or monitored Temple stations. The FBI would like tapes or transcripts of any communications from those stations. Any Amateur able to provide such information should contact the nearest FBI office.

NO HARMFUL NONTHERMAL EFFECTS were found to result from low-level microwave radiation by researchers reporting their results to the recent Symposium on Electromagnetic Fields in Biological Systems in Ottawa, Canada. More than a third of the 60 papers presented were on the effects of microwave radiation on various physiological systems, and not one of them reported finding any adverse effects other than heating from low-level radiation.

RF INTERFERENCE NEAR THE FCC'S monitoring stations is the subject of a new Notice of Proposed Rule Making, General Docket 78-365. In this proposal, the FCC suggests that radio operators in proximity to an FCC monitoring station consider what effect their operations may have on that station, and that they should consult with the monitoring station about their operations. The Notice would not require such consultation, however, but may indicate plans for more stringent future regulations such as those proposed below. Comment due date for the NPRM is January 22.

A Radio Quiet Area that now includes large areas of Virginia and West Virginia should also be applicable to Amateur Service and Class A CB operations, the Commission proposed in SS Docket 78-352. The area in question surrounds the National Radio Astronomy Observatory and the Naval Research Laboratory at Green Bank and Sugar Grove, West Virginia, within 39°15' and 37°30' north latitude and 78°30' and 80°30' west longitude. Only repeater operations would be affected, with operators required to consult with the director. Comments on this NPRM are due by February 1.

Relaxation of CW Requirements for handicapped Amateur Radio applicants (FCC General Docket 78-250) seems to have brought more negative than positive response from the handicapped. Comment Due Date on the docket has been extended to March 30 at the request of the Disabled American Veterans.

MORE ENCOURAGEMENT FOR AMATEUR RADIO comes from Geneva, following completion of a month-long WARC Special Preparatory meeting. The Amateur Service was well received by the 750 or so delegates (about 40 of them Amateurs), who represented 85 nations as well as dozens of recognized organizations, including the IARU. The meeting did not address such specifics as proposed frequency bands, but rather was directed toward broad topics such as needs, contributions, and the like. The results of the meeting — over 100 asserted documents — consisted of various recommendations and "conclusions."

For The HF And VHF Bands, the preferred parts of the spectrum for various types of Amateur operations were discussed, along with the desirability of exclusive Amateur allocations. The prospects of sharing with services such as radio location, which could provide additional frequencies for Amateurs with little or no significant interference, were also considered.

That Such Topics were discussed and adopted in this formative period without opposition is an encouraging sign that Amateur Radio will do well at next year's conference. It also indicates that the preparatory efforts made throughout the Amateur Radio world over the past few years are starting to pay off.

ARRL WILL CHALLENGE the FCC's linear amplifier ban in a formal court suit, the League's executive committee agreed at its mid-November meeting in Newton.

SAM HARRIS, KP4DJN/W1FZJ, passed away Saturday, November 4, at Arecibo, Puerto Rico. Among Sam's many accomplishments were the first Amateur Radio moonbounce contact (with KH6UK) and the first practical parametric amplifier. Sam was VHF editor for QST from 1960 through 1967, and served in the same capacity for CO from 1955 to 1960.
15, 25 and 30 amp regulated power supplies with fold back current limiting, over voltage and transient protection. Also, output voltage and current meters. You might find a cheaper power supply, but you can’t find one as well built with top quality components. Other power supplies with lighter weight transformers and components are no match for the VHF Engineering power supplies.

115/230 volt input – 50/60 cycle • Overvoltage protection • Fold back output limiter • Isolation from ground. The circuit is isolated from the case and ground. • Load regulation: 2% from no load to full load • Output voltage: adjustable 11 to 15 volts • Ripple: 50mV at rated current • Temperature range: operating 0 to +55 C • Black anodized aluminum heatsink.

PS15C 10 Amps cont. 15 Amps intermit. (50% duty cycle) 11 1/2 lbs. $124.95
PS25C 20 Amps cont. 25 Amps intermit. (50% duty cycle) 20 1/2 lbs. $179.95
PS3012 25 Amps cont. 30 Amps intermit. (50% duty cycle) 26 lbs. $249.95

AVAILABLE AT THESE DEALERS:

CALIFORNIA
C & A Electronic Enterprises, Carson, CA 90745, Ph. 213-834-5868
Telecom Electronics, San Jose, CA 95121, Ph. 408-274-4479
Zackit Corporation, Vallejo, CA 94590, 707-644-6676
COLORADO
A.E.S. Communications, Wes-Com, Colorado Springs, CO 80908, Ph. 303-475-7050
FLORIDA
Amateur Electronic Supply, Orlando, FL 32803, Ph. 305-894-3238
N & G Distributing, Miami, FL 33126, Ph. 305-592-9685
VHF/JAX, Orange Park, FL 32073, Ph. 904-264-7176
GEORGIA
Creative Electronics, Marietta, GA 30065, Ph. 800-241-4574
ILLINOIS
Klaus Radio, Peoria, IL 61614, Ph. 309-691-4840
Spectrum, Oak Park, IL 60304, Ph. 312-848-6777
IOWA
Bob Smith Electronics, Fort Dodge, IA 50501, Ph. 515-576-3886
MASSACHUSETTS
Tufts Radio Electronics, Medford, MA 02155, Ph. 617-395-8280
MICHIGAN
Adams Distributing, Detroit, MI 48228, Ph. 313-584-4640
The Ham Shack, Kentwood, MI 49508, Ph. 616-531-1976
MINNESOTA
PAL Electronics, Minneapolis, MN 55412, Ph. 612-521-4662
MISSOURI
Alpha Electronic Labs, Columbia, MO 65201, Ph. 314-449-1362
NEBRASKA
Communications Center, Lincoln, NE 68504, Ph. 402-466-3733
NEVADA
Communications Center West, Las Vegas, NV 89106, Ph. 702-647-3164
NEW YORK
Barry Electronics, New York, NY 10012, Ph. 212-326-7000
Delmar Electronics, W. Babylon, LI, NY 11704, Ph. 516-420-1224
VHF Communications, Jametown, VA 14701, Ph. 716-664-6345
OKLAHOMA
Universal Amateur Radio, Reynoldsburg, OH 43066, Ph. 614-866-4267
PENNNSYLVANIA
LaRue Electronics, Scranton, PA 18509, Ph. 717-343-2124
REPUBLIC
Derrick Electronics, Broken Arrow, OK 74012, Ph. 918-261-9923
SOUTH DAKOTA
Alpha Radio Communications, Watertown, SD 57201, Ph. 605-686-7314
TEXAS
AGL Electronics, Dallas, TX 75234, Ph. 214-241-6414
Madison Electronics Supply, Houston, TX 77002, Ph. 713-658-0268
VIRGINIA
Radio Communications, Roanoke, VA 24016, Ph. 703-342-8513
WASHINGTON
Adams Distributing, Seattle, WA 98155, Ph. 206-364-8300
WISCONSIN
Amateur Electronic Supply, Milwaukee, WI 53216, Ph. 414-442-4200
CANADA
Bytown Marine Ltd., Ottawa, Ontario, Canadian, K2H 7V1, Ph. 613-220-6910
Trapez Distributors, Richmond, BC, Canada, V6X 2A7, Ph. 604-278-1541

Vhf engineering
DIVISION OF BROWNIAN ELECTRONICS CORP.
320 WATER STREET / BINGHAMTON, NEW YORK 13901 / PHONE 607-723-9574
Prices and specifications subject to change without notice. / Export prices slightly higher.

More Details? CHECK — OFF Page 118
Back in 1975, after operating a converted Motorola 80D for several years, I decided to move up to a more versatile rig that I could synthesize and also use mobile. I looked at the available commercial rigs and synthesizers, every construction article I could locate, and talked to fellow hams who had gone this route. I found several rigs I liked, but no synthesizers; so, I decided to buy a rig (an HW202) and build a synthesizer. My first impulse was to build one that had appeared in a magazine construction article. I studied the circuit and started trying to locate parts, becoming quickly discouraged. After talking with a local ham who built a synthesizer from the same article, I was further discouraged.

At this point, I decided to design and build from scratch. Having found several rigs that I liked, I felt the synthesizer should be universal enough that I could simply reprogram the i-f offset and output frequency for another rig. In addition I wanted only one crystal oscillator, since that would reduce the stability problems and eliminate spurious outputs associated with mixers. I also wanted the entire synthesizer on one board; parts had to be inexpensive and easy to get. The end product was called the "400 PRO" (400 channels receive, 400 channels transmit with Programmable Receive Offset).

**Circuit Description**

The crystal oscillator, as shown in fig. 1, determines the overall frequency stability of the synthesizer. The crystal is a 1-MHz, parallel resonant cut for 32-pF load capacitance. For temperature stability, the crystal tolerance should be no more than .003 per cent from −23.5 to 66 degrees C (−10 to 150° F). U6 is a 7400 TTL NAND gate used as the oscillator.

U2, U3, and U4 divide the 1-MHz frequency by 600, producing a 1.666-kHz reference for the phase detector. The phase detector is made up of U1, U24, and U25. These three ICs were chosen over the more popular MC4044 phase detector strictly for a cost savings of about $1.50.

By Bob Fanning, K4VB and Gary Grantland, WA4GJT. Mr. Fanning’s address is 1332 Four Mile Post Road, Huntsville, Alabama 35802. Mr. Grantland’s residence is RFD 2, Somerville, Alabama 35670.
The next portion of the circuit description may be a little more difficult to understand. There are two counter chains and a two-modulus prescaler which make up the dividers necessary to divide the VCO output frequency down to 1.666 kHz (see fig. 2). U19, U20, and U21 make up the two-modulus prescaler. This circuit is arranged to divide the VCO frequency by 10 or 11, depending on the dc level at pin 11 of U6. The output of the two-modulus prescaler is fed to both counter chains.

The channel select divider, U11, U12, and U13, is programmed to divide by 400 plus the thumbwheel switch setting. If a frequency of 146.94 MHz is selected on the thumbwheel switches (6.94 is selected since all channels are in the 140-MHz band), the channel select divider divides by 400 plus 694, which equals 1094. This method is used so that it is impossible to select a frequency out of the 144 to 148 MHz range. When in the transmit mode, the i-f program divider, U16, U17, and U18, is always programmed to divide by 1360. When in the receive mode, the i-f frequency of the receiver being used is subtracted or added to 1360. For example, if the receiver has an i-f frequency of 10.7 MHz, high side injection, then 107 would be added to the 1360 when in the receive mode. This is done by programming the i-f program counter to the HT and LT buss on the printed circuit board. The HT buss is high, or a logic 1, when in transmit; it is low, or a logic 0, when in the receive mode. The LT buss is just the opposite of the HT buss. A ground buss and a +5 volt buss are also provided for the counter inputs, which remain the same in transmit and receive. The i-f program counter can be programmed to divide by 1200 to 1599, which corresponds to minus 16.0 to plus 23.9 MHz in 100-kHz steps. See table 1 for some standard i-f programming information and table 2 for developing any i-f program.

**table 1. Connections for the i-f offset dividers for standard receiver offsets.**

<table>
<thead>
<tr>
<th>Receiver Offset</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>J</th>
<th>K</th>
<th>X</th>
</tr>
</thead>
<tbody>
<tr>
<td>+5.5 MHz</td>
<td>HT</td>
<td>LT</td>
<td>LT</td>
<td>HT</td>
<td>0</td>
<td>HT</td>
<td>LT</td>
<td>LT</td>
<td>0</td>
<td>0</td>
<td>HT</td>
</tr>
<tr>
<td>−5.5 MHz</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>HT</td>
<td>0</td>
<td>HT</td>
<td>LT</td>
<td>LT</td>
<td>0</td>
<td>0</td>
<td>LT</td>
</tr>
<tr>
<td>+8.0 MHz</td>
<td>HT</td>
<td>LT</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>HT</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>HT</td>
</tr>
<tr>
<td>−8.0 MHz</td>
<td>HT</td>
<td>0</td>
<td>0</td>
<td>HT</td>
<td>LT</td>
<td>HT</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>LT</td>
</tr>
<tr>
<td>+10.7 MHz</td>
<td>HT</td>
<td>LT</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>LT</td>
<td>LT</td>
<td>0</td>
<td>LT</td>
<td>HT</td>
</tr>
<tr>
<td>−10.7 MHz</td>
<td>HT</td>
<td>0</td>
<td>LT</td>
<td>1</td>
<td>0</td>
<td>HT</td>
<td>LT</td>
<td>0</td>
<td>0</td>
<td>LT</td>
<td>LT</td>
</tr>
<tr>
<td>+12 MHz</td>
<td>HT</td>
<td>LT</td>
<td>0</td>
<td>HT</td>
<td>LT</td>
<td>HT</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>HT</td>
</tr>
<tr>
<td>−12 MHz</td>
<td>HT</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>HT</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>LT</td>
</tr>
<tr>
<td>+13.1 MHz</td>
<td>HT</td>
<td>LT</td>
<td>LT</td>
<td>HT</td>
<td>LT</td>
<td>HT</td>
<td>LT</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>HT</td>
</tr>
<tr>
<td>−13.1 MHz</td>
<td>HT</td>
<td>0</td>
<td>0</td>
<td>HT</td>
<td>0</td>
<td>1</td>
<td>LT</td>
<td>0</td>
<td>LT</td>
<td>0</td>
<td>LT</td>
</tr>
<tr>
<td>−11.7 MHz</td>
<td>HT</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>HT</td>
<td>LT</td>
<td>0</td>
<td>0</td>
<td>LT</td>
<td>LT</td>
</tr>
</tbody>
</table>

The output of U16, a negative-going 20 ns pulse, is lengthened to about 50 ns by U10. The subsequent output of U10 is inverted and buffered by U6 and used to load the counter chains with the jam inputs when the i-f program counter counts down to zero. The remainder of U6, which is connected as an RS latch, has a high output when the channel select divider counts down to zero, and a low output when the i-f program divider counts down to zero. When the output, pin 11, is low, the two-modulus prescaler divides by eleven; when pin 11 is high, the prescaler divides by ten.

Assume that the receive frequency is 146.94 MHz and the receiver has an i-f frequency of 10.7 MHz, with low-side injection. The i-f program divider would be set at 1360 + 107 = 1253. The channel select divider would be set at 400 + 694 = 1094. The outputs of U6 load both counter chains and set the prescaler to divide by eleven. After 1094 counts, the prescaler is set to divide by ten; the prescaler is reset to divide by eleven after 1253 − 1094 = 159 counts. Therefore, the prescaler divides by eleven 1094 times and divides by ten 159 times. The frequency input to prescaler required to receive 146.94 MHz would be...
fig. 2. Diagram of the counter portion of the synthesizer. U11, U12, and U13 make up the channel select dividers, dividing by 400 plus the frequency selected. For example, \(400 + 625 = 1052\) for 146.52 MHz. The i-f program dividers, U16, U17, and U18, are normally programmed to divide by 1360 when in the transmit mode. When receiving, the dividers are programmed by jumpers to change the divide number according to the receiver i-f offset used.
(146.94 \times 10^6 - 10.7 \times 10^6)/6 = 22.7066 \times 10^5.
Divided by \(11 \times (1094) + 10 \times (159) = 1.66666 \times 10^3\), or the same as the output of the reference frequency divider.

These two signals, when compared by the phase detector, generate an error voltage which controls CR1, CR1, C18, and L1 make up the VCO tank circuit. The capacitance of CR1 can be varied from 30 to 80 pF, depending on the bias voltage. L1 is adjustable from 0.5 to 1 uH. L1 and C18 are adjusted to center the VCO frequency. Before adjusting L1 and C18, the i-f program counter chain should be pro-

the VCO. There are two outputs from the phase detector which drive pins 3 and 5 of U22. If no error voltage is generated, the level at pin 7 of U22 is 4 Vdc. If an error voltage is present, negative or positive pulses will be present at pin 7 of U22. The remainder of U22 is a four-pole, lowpass filter. At the output of the filter, the 1.666-kHz signal is 85 dB below the input.

The dc voltage from the filter biases the varactor, programmed for the i-f frequency of the receiver and the channel select divider should be set to 146.00 MHz. For receivers with low-side injection, adjust L1 in transmit and C18 in receive mode for minimum ac voltage at pin 7 of U22. This can be done with an oscilloscope or ac voltmeter. Adjust L1 in receive and C18 in transmit for receivers with high-side injection. This adjustment is not critical and will affect only the frequency deviation of the VCO. Terminal X

fig. 3. Parts placement diagram for the circuit board of the two-meter synthesizer. The jumpers for the output and i-f offset frequencies are explained in the tables.
is strapped to HT or LT and adds C18 to the tank circuit when X is high. Q2 and U14 buffer the VC0 and drive the two-modulus prescaler and U15, a dual J-K flip-flop which may be programmed to divide by two, three, or four. The output is buffered by U14 to drive the transmitter and receiver crystal oscillators.

The PTT input should be grounded during transmit. This turns Q3 off. Q3 is buffered by U9 and provides the HT and LT levels to drive the thumbwheels used for transmit and receive. This provides any split or simplex operation on any set of thumbwheels.

assembly

Assembly of the printed circuit board is straightforward and requires no special tools or techniques (it does require good grounding, however). Boards are available from the author* and will be by far the easiest route to go. If you prefer to lay out your own circuit board, care should be taken in the placement of components and traces to prevent the introduction of VC0 whine and switching transients onto the signal lines. It is strongly recommended that a double-sided printed circuit board by used, as this is largely the secret to success in the virtual elimination of VC0 shielding, the use of only one board, and the absence of "trash" on the output signal. Vector-type boards should not be used, because of the difficulty in attaining the high degree of shielding necessary. The very first 400 PRO built was on vector board. It was tough to get the output clean and it required two boards, one for the VC0 and another for the rest of the synthesizer. It was also necessary to cover the entire VC0 with a metal can and place a third copper clad board between the two main boards, with everything securely grounded.

Component placement and sizes should be kept as near as possible to those shown in the component placement drawing (fig. 3). All parts used, with the exception of the VC0 coil and cover and copper pipes over C18 and C20, are available from most parts houses advertising in this magazine. For best re-

In this view you can see the if transformer can, which is used to shield the varactor and coil. Also notice that the board mounting technique provides four secure grounds.

sults, IC sockets should not be used. However, if they are used, a good quality socket is a must. First-run ICs should be used if at all possible, as problems can be encountered with "discount house" ICs. As a general rule, most discount houses will quickly replace any bad IC. Nevertheless, replacement of bad ICs is little compensation, in many cases, for the misery encountered in finding them in a circuit.

A suitable source for the VC0 coil and cover is the 6.5-mm (1/4-inch), four-terminal transformer used in the i-f of commercial fm receivers. Strip off the existing coil and wind 17 turns (close wound) of number 32 (0.2-mm) AWG enamel wire, terminating on two of the four terminals. (See fig. 3 for the correct terminals.) The MV-2209 varactor should be connected to the other two terminals, and both the coil and varactor should be covered with Q-dope and then placed back in the can. The can mounting tabs should be soldered to the ground point on the printed circuit board. If the VC0 coil slug is not tight, the VC0 will become sensitive to mechanical shock. If this occurs, the output of the VC0 will sound just like a microphonic tube on both transmit and receive. The solution to this problem is fairly simple: after final VC0 adjustment, apply a drop of candle wax or

*Double-sided, plated-through, G10 printed circuit boards with complete instructions (58.75$), completely assembled and tested boards (589.00), and coil assembly with MV2209 (53.50) are available from G&F Electronics, P.O. Box 4151, Huntsville, Alabama 35802.

Table 3. Connection to U15, the output divider, for different transmitter/receiver multiplication factors.

<table>
<thead>
<tr>
<th>receiver multiplier</th>
<th>transmitter multiplier</th>
<th>jumpers</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>6</td>
<td>M-S, M-L</td>
</tr>
<tr>
<td>6</td>
<td>12</td>
<td>M-L, P-S, V-GND, R-HT</td>
</tr>
<tr>
<td>6</td>
<td>18</td>
<td>M-L, N-S, V-P, T-HT</td>
</tr>
<tr>
<td>6</td>
<td>24</td>
<td>M-L, N-S, T-HT</td>
</tr>
<tr>
<td>12</td>
<td>6</td>
<td>M-S, P-N, V-GND, R-LT</td>
</tr>
<tr>
<td>12</td>
<td>12</td>
<td>L-P, N-S, V-GND</td>
</tr>
<tr>
<td>12</td>
<td>18</td>
<td>U-L, V-N, P-S, R-HT</td>
</tr>
<tr>
<td>12</td>
<td>24</td>
<td>U-L, P-S, R-HT</td>
</tr>
<tr>
<td>18</td>
<td>6</td>
<td>M-S, L-N, V-P, R-HT</td>
</tr>
<tr>
<td>18</td>
<td>12</td>
<td>L-P, U-S, V-N, R-LT</td>
</tr>
<tr>
<td>18</td>
<td>18</td>
<td>L-N, V-P, N-S</td>
</tr>
<tr>
<td>24</td>
<td>6</td>
<td>M-S, L-N, T-LT</td>
</tr>
<tr>
<td>24</td>
<td>12</td>
<td>L-N, U-S, R-LT</td>
</tr>
<tr>
<td>24</td>
<td>24</td>
<td>L-N, P-S</td>
</tr>
</tbody>
</table>
similar material onto the slug. Remember, if you should later change to a rig that has a different i-f offset, the VCO may require a touchup. Don’t lock the slug down too tightly.

The covers over C18 and C20 were made from 9.5-mm (3/8 inch) copper tubing cut in 12.5-mm (1/2-inch) lengths and soldered to the shield side of the printed circuit board. Care should be taken to prevent the inside of the copper tube from shorting the capacitor to ground. A piece of thin Mylar or Teflon sheet wrapped on the inside of the tubing will serve as a spacer. The Mylar used in drafting departments for taping printed circuit board masters is excellent for this purpose. The tubing should be quickly soldered in place using a hot iron. A thin strip of copper 1 mm (0.03 inch) thick should be soldered in place on the component side between Q2, Q4, and U6, U10 as shown in fig. 3. This 5 cm x 1.3 cm (2 x 0.5 inch) shield is sometimes needed to prevent VCO whine. Since it is cheap and easy to install, one should be used as a preventive measure.

The enclosure shown in the photographs was handmade from 1.5-mm (0.062-inch) aluminum sheet and painted with enamel paint. The lettering was applied using a Leroy lettering set with black India ink. Press-type, dry-transfer decals will also work quite well. The lettered surface should be protected with a clear Krylon spray.

The enclosure shown in the photographs has no means of ventilation. Ventilation is recommended to reduce heat build-up, thus improving frequency stability. The unit shown was accidentally left on inside a closed vehicle on a 38°C (100°F) day with no ill effects, except for the fact that the cover became hot enough to burn your hand.

Most importantly, the box used should be one with good rf integrity. This usually means all metal with good metal-to-metal contact between pieces. Plastic panels should not be used, nor should metal boxes with vinyl contact coating. The Radio Shack box 270-254 is the most suitable commercially available one I found. It costs about $5.00 and has only one shortcoming: The front panel is thin-gauge aluminum which is a little too flimsy and thin for Digitran 2300-series thumbwheels. This problem can be corrected by gluing strips of aluminum behind the front panel and on each side of the thumbwheel switches to act as shims.

The printed circuit board should be mounted at all four corners with a good solid ground connection to the box. Make sure that your spacers do not extend beyond the copper pads provided on the circuit side of the printed circuit board, as this can cause portions of the circuit to short to ground.

The printed circuit board should be positioned such that the transmit and receive outputs are just below the rf output connections on back of the box. Lowpass filters should be used between the printed circuit board and rf output connectors (see fig. 4 for values). If lowpass filters are not used, short pieces of buss wire (2.5 mm [1 inch] or less) should be used.

The 3-ohm, 3-watt resistor (R1) should be connected directly to the LM309K input pin and clamped against the rear panel for mechanical strength and heat transfer. C2 and C3 should be connected to the LM309K terminals and grounded to a lug under one of the 309K mounting screws (C2 and C3 should be ceramic). The +12 volt input should enter the box through a 0.01-μF feedthrough capacitor.

If needed, the PTT line can enter through a feedthrough capacitor. However, no situation has been encountered where an RCA phono jack with a 0.1-μF capacitor to ground would not suffice. All rf output connectors are RCA phono-type, but any good quality rf connector with a good ground connection will work well.

The thumbwheel switches used are the Digitran 2300-series. Any thumbwheel or rotary switch providing BCD output can be used. Lever-type thumbwheels were not used for fear of unintentional frequency changes caused by the microphone cord. Rotary switches were not used because the larger front panel required was not desirable.

programming the synthesizer

Jumper wires should be used to connect terminals

A through K to the HT, LT, +5 volts, or GND buss to program the synthesizer to match the i-f frequency of your receiver. Terminal X should be connected to HT for receivers that use high-side injection, and connected to LT for receivers that use low-side injection. Table 1 lists several i-f frequencies and the
proper connections for programming. Receivers with i-f frequencies, other than those listed in Table 1, can be programmed using the following example. Table 2 lists the BCD values that correspond to terminals A through K. The left-hand column lists the transmit and receive values that should be programmed. The transmit value is always 1360. The receive value is determined by the receiver i-f frequency. If the receiver i-f frequency is 10.7 MHz, as required, by the addition of series resistance at the point of interface. Any additional interfacing components should be as close to the interfacing point (usually the crystal socket) as possible. Optimum results are obtained if connections are soldered at the interface point. Satisfactory results should be obtained by plugging into an unused crystal socket. If this method is used, insure that all mechanical connections are solid.

Table 2 lists the BCD values that correspond to terminals A through K. The left-hand column lists the transmit and receive values that should be programmed. The transmit value is always 1360. The receive value is determined by the receiver i-f frequency. If the receiver i-f frequency is 10.7 MHz, as required, by the addition of series resistance at the point of interface. Any additional interfacing components should be as close to the interfacing point (usually the crystal socket) as possible. Optimum results are obtained if connections are soldered at the interface point. Satisfactory results should be obtained by plugging into an unused crystal socket. If this method is used, insure that all mechanical connections are solid.

With some transceivers, one side of the crystal is switched with the channel selector while the other side is connected to ground through a trimmer capacitor. Interfacing with this type of transceiver is best accomplished by adding a solid chassis ground to which the 400 PRO ground (shield side of coax) should be connected. The center conductor is then connected to the switched side of the crystal socket (through the proper interfacing components).

The basic requirement for operation is adequate drive at the appropriate frequency, which need not necessarily be exactly the same as the crystal it replaces. For example, if your receiver requires a 48-MHz crystal (as does the HW202), it will work quite well with a 24-MHz signal. The oscillator will then act as a doubler. Other transceivers require a 15-MHz crystal, which is multiplied by nine. These oscillators will operate with a 23-MHz input multiplied by six.

The 400 PRO, as wired in this article, will work the entire two-meter band. Few transceivers are broad enough to allow full power output or maximum sensitivity across the entire band. Don't be alarmed if a couple of MHz is your limit. This problem is very pronounced with commercial-band radios such as Motorola and GE.

When interfaced properly, the transceiver will
work just the same with the 400 PRO as with a crystal. If it does not, it is either not interfaced properly or other problems exist. The most common other problem is rf leakage into the 400 PRO. The symptoms of rf leakage are distorted or low frequency audio on transmit. This distortion may come and go when the equipment is moved. In some cases, movement of the microphone, rf or audio cables, nearby objects, or even people can cause the intermittent distortion. In severe cases, the movement of one's hand near the equipment can cause distortion. The most common cause is poor or missing ground connections. Signals can also be coupled in via either the transmitter, receiver, PTT, or the +12 volt line. Any problems entering on the +12 volt or PTT line can be eliminated by the use of feedthrough capacitors. Coupling through the transmitter or receiver lines can be eliminated by the addition of a lowpass filter inside the 400 PRO. In extreme cases, an additional lowpass filter may be required at the transmitter end of the coaxial cable. The filter can be the same as in the 400 PRO and should be mounted inside the transceiver at the point of entry; ground it well. If filtering is done after interfacing, recheck the drive levels.

The 400 PRO can be used in one crystal position, with crystals used in others. With this set-up, the 400 PRO should be turned off any time the transceiver is used in a crystal mode. Failure to do so can result in spurious output in the transmit mode and unwanted birdsies in the receive mode.

Interconnecting cables between the 400 PRO and your transceiver should be a good quality 50-ohm coax; the miniature RG-174 works very well. Never use audio cable, shielded or unshielded. Good grounding is an absolute must. Short interconnecting cables are obviously best, but several 400 PRO’s are now being used with trunk-mounted, commercial-band equipment. (I use one with a Motrac U43MHT.) Miniature coax is used between the dash-mounted 400 PRO and the trunk-mounted radio. One potential problem with commercial-band radios is high resistance in the tensile cord push-to-talk line. This manifests itself in the inability to switch the 400 PRO from receive to transmit. The problem can be corrected by either replacing the microphone cord or reducing the resistance such that Q3 will switch when the PTT button is pressed.

direct fm

Most transmitters are phase modulated instead of true fm. However, for those that are true fm, the 400 PRO will not simply plug into the crystal socket and function. The phase lock action of the 400 PRO will not allow the output frequency to be shifted. To solve this problem, the VCO in the 400 PRO must be direct-fm modulated. This is accomplished by applying audio from the transceiver directly to the 400 PRO VCO. Fm produced in this manner is of superior quality. The 400 PRO can be frequency modulated when used with either fm or pm rigs.

5-kHz offset

The 400 PRO was not designed for 5-kHz output steps. A very simple modification, however, can be made that will provide 5-kHz output increments. This is accomplished by the addition of a toggle-switch selectable capacitor (see fig. 5) which will alter the divide ratios. The change will result in an error of 34 Hz/MHz at the two-meter output frequency. For example, if the 400 PRO is set up for no error at 146.005 MHz, the transceiver will exhibit a 67-Hz error at each end of the band (144.000 to 147.995). When not in the 5-kHz mode, the 400 PRO will operate normally and will have no error caused by this modification.

The off-set capacitor shown in fig. 5 can be mounted on the printed circuit board or at the toggle switch. Interconnecting cabling (RG-174) should be kept as short as is practical (15 cm [6 inches] or less).

The easiest method found for initial setup is to calculate the required transmit frequency, with and without +5 kHz off-set. With the off-set selected, adjust C20 for the required frequency. Switch back to the normal position and pull the frequency back down as required with Coffs. You may have to repeat this procedure a couple of times. The transmit mode was chosen for initial setup because of the calculation — no i-f off-set is involved.

After the 400 PRO is interfaced to your rig and working properly, the same adjustment procedure can be used while monitoring your transmitter output frequency with a frequency counter. Once properly adjusted in the transmit mode, the receive frequency is automatically set and will require no further adjustment.

conclusion

Although many 400 PROs have been built and used with a variety of rigs, additional interfacing information is always welcome. If you encounter any unusual interfacing problems to which you find a solution, it would be greatly appreciated if you would jot down the details and mail them to me. By the same token, if you encounter problems you cannot solve, I will be glad to try to help you. The following information must be furnished: transmit and receive crystal formulas, multiplier arrangement, and a schematic. If you are going to have a problem with the 400 PRO, it will most likely be in interfacing it to your rig.

ham radio
THE SWITCH IS ON!

Not only is the big move to switch to the Wilson Mark Series of Mini-Hand-Held Radios, but now the switch is on the Mark!

Wilson Electronics, known for setting the pace in 2m FM Hand-Helds, goes one step beyond!

AT NO EXTRA CHARGE: all Mark Series Radios now will include a switch for you to control the power of operation. This will enable you to use the high power when needed, then later switch to low power to conserve battery drain for extended operation.

IN ADDITION: all Mark Series Radios now have an LED Battery Condition Indicator conveniently mounted on the top plate. A quick peek will reassure you of a charged battery in the radio.

Wilson hand-helds have been known world-wide for exceptional quality and durable performance. That's why they have been the best selling units for years.

Now the Mark Series of miniature sized 2-meter hand-helds offers the same dependability and operation, but in an easier to use, more comfortable to carry size . . . fits conveniently in the palm of your hand.

The small compact size battery pack makes it possible to carry one or more extra packs in your pocket for super extended operation time. No more worry about loose cells shorting out in your pocket, and the economical price makes the extra packs a must.

Conveniently located on top of the radio are the controls for volume, squelch, accessory speaker mike connector, 6 channel switch, BNC antenna connector and LED battery condition indicator.

Illustrated is Wilson's BC-2 Desk Top Battery Charger shown charging the Mark Series Unit or the BC-4 Battery Pack only.

To obtain complete specifications on the Mark II and Mark IV, along with Wilson's other fine products, see your local dealer or write for our Free Amateur Buyer's Guide.

---

NOW SWITCHABLE
MARK II: 1 & 2.5 watts
MARK IV: 1 & 4.0 watts

SPECIFICATIONS
- Range: 144-148 MHz
- 6 Channel Operation
- Individual Trimmers on TX and RX Xts
- Rugged Lexan® outer case
- Current Drain: RX 15 mA
  TX - Mark II: 500 mA
  TX - Mark IV: 900 mA
- 12 KHz Ceramic Filter and 10.7 Monolithic Filter included.
- 10.7 MHz and 455 KHz IF
- Spurious and Harmonics: more than 50 dB below carrier
- BNC Antenna Connector
- .3 Microvolt Sensitivity for 20 dB Quieting
- Uses special rechargeable Ni-Cad Battery Pack
- Rubber Duck and one pair Xts 52/52 included
- Weight: 19 oz. including batteries
- Size: 6" x 1.770" x 2.440"
- Popular accessories available: Wall Charger, Mobile Charger, Desk Charger, Leather Case, Speaker Mike, Battery Packs, and Touch Tone™ Pad.

Consumer Products Division
Wilson Electronics Corp.
4288 South Polaris Avenue • P. O. Box 19000 • Las Vegas, Nevada 89119
telephone (702) 739-1931 • TELEX 684-522
optimizing and measuring fm deviation

Louder isn't necessarily better in an fm transmitter — intelligent use of the deviation control will produce maximum talk power per watt

In fm radio transmission, the louder the modulating signal into the microphone the greater the variation of the carrier from its center, or resting, frequency. Generally this also means a stronger audio signal at the detector of a properly tuned fm receiver. The amount of the plus or minus frequency swing is called deviation. Deviation is talk power, and that's good — most of the time but not always.

There are three conditions under which increased deviation is not to the user's advantage. First, FCC Regulation Part 97.65 limits the deviation to ±3 kHz on frequencies below 29.0 MHz and between 50.1 and 52.5 MHz. Deviation is limited to ±20 kHz for all other authorized Amateur Radio frequencies. Continued violation of the regulation could result in zero talk power. Get the message?

Second, particularly in the 2-meter band, interference between stations operating on different frequencies is minimized if the portions of the frequency spectrum used by each of the stations don't overlap. This is shown graphically in fig. 1. The amateur community long ago recognized the potential for a problem and used some of its better thinking to find ways for avoiding the interference. The solution is best seen in the band plans for 2-meter repeater operation, where the generally used frequencies are 10 kHz apart, corresponding approximately to a ±5 kHz deviation limit.

The decision to self-impose a 5-kHz deviation limit when the FCC was offering up almost four times that much wasn't entirely magnanimous. (Required band-

By Ray Isenson, N6UE, 4168 Glenview Drive, Santa Maria, California 93454
width is approximately $2 \times \text{deviation} + \text{maximum modulating frequency}$. Thus, for a 3-kHz modulating frequency, and FCC permitted maximum deviation, the required bandwidth would be $\frac{40 - 3}{2} = 18.5$ kHz.) This becomes evident in an examination of the third condition, under which it’s to the user’s advantage to limit the deviation.

**modulation index**

In fm radio transmission, the total power radiated is independent of the modulation. When the carrier is modulated (deviated), power is transferred from the carrier to the intelligence sidebands. The amount of power that’s transferred depends on the modulating-signal amplitude and something called the modulation index (MI). We noted previously that the achieved deviation varies with the modulating-signal amplitude. The modulation index is the ratio of the frequency deviation to the modulating-signal frequency.

For example, if a transmitter deviates 5 kHz with a modulating signal of 2 kHz, at some amplitude the modulation index would be $\frac{5}{2} = 2.5$. The relationship between the relative amount of power in the carrier and sidebands and the modulation index is shown in fig. 2. It’s evident that the maximum amount of power is transferred to the sidebands when the modulation index is approximately 2.4; that is,

$$MI = \frac{\text{Dev}}{F_m} = 2.4$$  \hspace{1cm} (1)

**audio bandwidth**

Students of audio-frequency phenomena know that, although the full spectrum of human speech is between approximately 100 and 8000 Hz, only a small fraction of that range is normally used. If everything below 1000 Hz is filtered, comprehension is not affected, but the result is a mechanical, unnatural sound. If frequencies above 1000 Hz are filtered, the result is a varying amplitude mumble that’s almost devoid of intelligence. As more and more of the frequencies above 1 kHz are permitted to pass, comprehension increases rapidly until about 1800 or 2000 Hz is reached. Comprehension then increases less rapidly until, by 3000 Hz, almost nothing is added to comprehensibility by increasing bandwidth. If eq. 1 is examined in light of this:

$$MI = \frac{\text{Dev}}{F_m} = 2.4$$

$$\text{Dev} = F_m \times 2.4 = (1 \text{ kHz to } 2 \text{ kHz}) \times 2.4$$ \hspace{1cm} (2)

$$= 2.4 \text{ kHz to } 4.8 \text{ kHz}$$

Thus, the most effective way to use the rf power and obtain maximum readability is to hold the achieved deviation between about 2.5 and 4.5 kHz; the lower number for bass-voiced males, the higher number for tenors and sopranos. Thus it’s possible at one and the same time to keep the FCC and fellow hams happy — or, at least, off your back — and to make efficient use of the rf power from the transmitter. Adjusting the transmitter to achieve the desired and maximum deviation isn’t difficult. It consists solely of tweaking a couple of potentiometers while making a few measurements.

**audio gain and deviation controls**

Typically, the signal from the microphone is ac-coupled to a one- or two-stage audio amplifier; then to a clipper and filter, then to a deviation-level control stage, and finally to the modulator. Most, but not all, transmitters have a means of gain adjustment in the audio amplifier stage. All fm transmitters should have a potentiometer for controlling deviation-level set, or, maximum deviation. Really good matching of the microphone, the user’s speech characteristics, and the transmitter can be accomplished only when both

---

**fig. 1.** With center frequencies 10 kHz apart, two fm stations will still experience some mutual interference if each modulates to 4.5-kHz deviation with a 1.5-kHz tone.

**fig. 2.** Relative amplitude of the rf power remaining in the carrier as a function of modulation index.
controls are present. If only a deviation-level set control is available a useful degree of optimization is still possible, although the user may have to experiment with different microphones to get the best match.

**an analogy**

To visualize the interaction between audio gain control and deviation level set, it’s convenient to use a simple analogy. Picture a small system made up of a water well, an electric pump, a faucet, and the connecting pipes. It’s clear that until the pump is turned on no water will flow, faucet open or closed. Now, turn on the pump with the faucet closed and still no water flows. As the faucet is gradually opened, more and more water will flow until the maximum flow rate of the pump is reached. After that, further opening of the faucet results in no further flow increase.

Thus we see that the pump really determines the flow rate; the faucet can only limit it. And so it is with the audio amplifier and deviation-level controls. The amplifier is the pump; the deviation control is the faucet. The point is that the amplifier establishes the average deviation achieved during transmission. The deviation control provides a high side limit to the deviation.

**setting the deviation**

For best results, audio amplifier gain should be set to place the achieved deviation somewhere between 2.5 and 4.5 kHz for normal speech, as previously described; and the deviation level should be set to limit the deviation to 5 kHz on very loud sounds into the microphone. At the same time, care must be taken to avoid overdriving the audio amplifier so that speech fidelity will be maintained. Audio gain can be set only with an oscilloscope. A deviation meter is required for the remaining adjustments. The circuit for a simple, inexpensive deviation meter is described later.

Two representative audio input circuits are shown in fig. 3. One consists of discrete components; the other, an integrated circuit. The oscilloscope is connected to point A, and audio gain is varied with the setting of R1. Excite the microphone with a steady tone in a normal speaking voice. This can be done,

![fig. 3. Typical fm-transmitter audio input circuits.](image-url)

for example, by saying “fo-o-o-ore,” as on a golf course, while varying R1 until the audio peaks are barely flattened as seen on the scope. Even in the absence of an audio-gain control this is a good check. If it’s necessary to holler into the microphone to get limiting, a new mike may be in order.

**simple deviation meter**

A minimal deviation meter consists of a suitable radio receiver and a calibrated, peak-reading voltmeter. The accompanying photograph shows such a device. It consists of the metering circuit shown in fig. 4 and a commercial scanner. Most of the circuit is mounted on a 25.4 × 38 mm (1 × 1.5 inch) printed circuit board fitted into the scanner. Voltage is taken from the scanner power supply. The only modification to the scanner is the removal of a capacitor, as described later. The scanner function is not affected. Contained in the meter housing are the two switches, the calibration pot, and the smoothing capacitor. The exact layout of the printed circuit board depends on the transformer and the meter-input pot used, so it’s not shown here. The layout isn’t at all critical. Any fm receiver capable of precise
tuning to the carrier frequency of the transmitter to be tested can be used. In many cases, no modification to the receiver need be made. At most, as discussed later, it may be necessary to lift, temporarily, one end of a capacitor to use the receiver.

**component selection**

None of the voltmeter component values are critical. The diagram represents what I had in my junk box. I salvaged the diodes from surplus computer boards. Those selected had the lowest reverse current (cataloged, not measured). If you don’t have a 100-microampere meter, the 50-microampere VU meter, 5E3705, currently offered by PolyPaks for just over $1, is most acceptable. Transformer T1 was salvaged from a junked, transistorized a-m broadcast receiver. Anything with a 1k - 10k input impedance and with a transformation of two to three times that impedance in the center-tapped secondary will do. If all else fails, and your junk box is as barren as Mother Hubbard’s cupboard, a Triad A31X, Stancor TA31, or Allied interstage 6T14PC would be ideal.

Referring to fig. 4, C1 is an input coupling capacitor for U1. Any value between 10 and 100 microfarads will do for capacitor C4; its function is to stabilize the voltage across CR3. The 40μF capacitor (C3), shunting pot R5, and the meter provide meter damping. The optimum value of C3 depends on the internal resistance of the meter and the magnitude of the calibration resistance. I tried several values between 10 and 200 microfarads before deciding that, for my setup, the 40-microfarad capacitor was adequate. The meter movement was damped but not to the point of being sluggish. It’s a matter of personal preference.

**precalibration notes**

Before discussing meter calibration, I should comment on a possible need for temporary modification of the receiver. To reduce the consequences of thermally induced noise in the a-f amplifiers, it’s customary to use frequency pre-emphasis and de-emphasis. The fm transmitter emphasizes the higher audio frequencies by shaping the amplifier-response curve ahead of the de-emphasis circuit. When discrete circuit by lifting the ground side of a capacitor. If the

fig. 4. Schematic of a simple deviation meter discussed in the text. Component values are not critical.

is a type CA3065, MC1358, µA3065, ULN2165, C6063P, or SK3072, lift the ground side of the capacitor connected to pin 7 and connect the meter at pin 14. If it is a type CA2111A, MC1357P, C6062P, or SK3135, lift the ground side of the capacitor connected at pin 14 and pick up the signal on pin 1. For other chips consult the manufacturer’s data or perhaps the receiver circuit diagram. Look for a capacitor in the range 0.005 - 0.1 microfarad from a pin to ground and not by-passing a resistor. I removed the 0.005-microfarad capacitor from the de-emphasis circuit in my Pace scanner and found that it made so little difference in the audio quality that it was never replaced.

**meter calibration**

Having ensured the readings will be free of de-emphasis effects, meter calibration is straightforward. The easiest way to do this is to use a digitally synthesized transmitter as a signal source.

First, disconnect the transmitting antenna and connect a suitable dummy load. Tune the transmitter and the receiver to be used with the deviation meter to the same frequency. Close the transmit switch with no modulation present and measure the dc voltage at the discriminator or detector output. Be sure to use a dc-coupled oscilloscope or a high-impedance voltmeter. If both rigs are tuned to frequency and the discriminator is properly balanced, there will be zero volts out. If some other voltage is sensed, find out why and correct it before proceeding.

Next, shift the transmitter frequency up 5 kHz by using the PLUS 5 KHZ switch on the transmitter. Read and note the voltage at the discriminator output. It will be on the order of 1 volt. Now, leave the 5 KHZ switch alone but decrease the transmitter frequency 10 kHz. Voltage at the discriminator should be of the same magnitude but of opposite polarity to that previously measured. That is, if it was +1 volt, it...
and can be used to set the deviation-limit level of the prototype. The deviation meter is now calibrated to the desired 5 kHz at center scale. I chose, rather arbitrarily, to make the meter linear up to 7.5 kHz to allow for some padding beyond the region of primary interest. You may want to use some other numbers. Changes from the following procedure to yield numbers of your choice should be obvious.

**meter linearity**

Assuming the 7.5-kHz linear range is acceptable, set the output of an audio-frequency generator so that its peak-to-peak value is three times the previously measured 5-kHz deviation output voltage. (Note that for 10-kHz linearity, the p-p reading should be four times the reading previously measured.)

The frequency isn’t critical. If nothing else is available, use a 60-Hz signal. A 1000 - 3000 Hz signal is preferred. Feed the signal to the deviation-meter input while observing the output waveform (pin 6 of the LM380) on your oscilloscope. Adjust the potentiometer connecting pins 2 and 3 of the IC for maximum signal output without limiting or other distortion. This establishes meter linearity.

Decrease the injected-signal amplitude until it’s twice the 5-kHz deviation voltage. Again, this is peak-to-peak voltage. Adjust the meter series pot until the needle points where desired (center scale on the prototype). The deviation meter is now calibrated and can be used to set the deviation-limit level of the transmitter being adjusted.

calibration using a frequency counter

In the absence of a digitally synthesized transmitter, the deviation meter can be calibrated using an audio signal generator and a frequency counter. The technique involved derives from further application of eq. 1. At a modulation index of 2.4 there’s no power in the carrier, all of it having been transferred to the sidebands. For a deviation of 5 kHz, a modulating frequency of 2080 Hz is necessary to get an MI of 2.4. \( \frac{5000}{2080} = 2.4 \).

Set up a transmitter and the receiver to be used with the deviation meter on a common frequency, as before. This time, however, adjust the discriminator very slightly so that a dc voltage is measured in the presence of unmodulated rf. Now inject the 2080-Hz signal into the audio input of the transmitter. It can be audio coupled through the microphone or directly coupled, whichever is convenient. Increase the injected-signal amplitude from a very low level while observing the dc voltage at the discriminator output. This voltage will drop to zero when the injected-signal amplitude corresponds to a 5-kHz deviation. Holding the amplitude constant, drop the frequency to about 1000 Hz and tweak the series pot used for calibrating the meter until the latter indicates 5 kHz. Check pin 6 of the LM380 to make sure that the sine wave at that point isn’t distorted. If it is, adjust the pot across pins 2 and 3 of that chip to remove the distortion, and readjust the meter calibrating resistor as necessary.

setting deviation

Excite the microphone with any loud, high-frequency tone — a loud sustained whistle is adequate. Adjust the deviation level control so that the deviation meter reads no more than 5 kHz. Talking into the microphone in normal tones should yield an average deviation of 2.5 kHz to 3.5 or 4 kHz — again depending on individual voice pitch. If it’s much less than this, and if the rig has an audio gain control, try increasing the gain slightly. Recall, however, that the gain control was previously set at the upper level of the amplifier’s linear range. Therefore a tradeoff between amplitude and amplitude linearity will have to be made.

If a TOUCH TONETM pad is used, the high tone group should cause a deviation meter reading of 4 - 4.5 kHz; for the low tone group, it should be about 3 kHz.

You’ve now properly set the average and maximum deviation on your fm transmitter. Stand by to pride yourself on the fact that your rig is giving you maximum talk power per watt input, and that you’re one of the good guys when it comes to bandwidth conservation.
Super Terminals with Hidden Features

For super operator convenience,
Our keyboard works in MORSE, BAUDOT, and ASCII codes and controls the terminal, too.
You can edit a message, program the HERE IS message, send the "QUICK BROWN FOX . . ." test message, change speeds, and change the terminal modes, all from the keyboard itself. In fact, the KOS (Keyboard Operated Switch) feature even turns the transmitter on and off from the keyboard. The DS-3000 KSR also features full-length 72 character lines (16 lines per screen), 5 speeds of BAUDOT and ASCII RTTY and Morse code from 1 to 175 wpm (Version 3), and word wrap-around to prevent splitting of words at the end of a line. When combined with the HAL ST-6000 Demodulator, you have the ULTIMATE in RTTY equipment.

DS-3000 KSR Version 3 (MORSE, BAUDOT, ASCII) .......................... $1195.00
DS-3000 KSR Version 2 (BAUDOT & ASCII only) .......................... $1750.00

Write for our latest catalog & RTTY guide.
10-GHz Gunnplexer transceivers —
construction and practice

Discussion of the various aspects of Gunnplexer transceiver construction and operation, including two practical transceiver designs.

Microwave communications is one of the last frontiers of Amateur Radio; thanks to the Gunnplexer transceiver module offered by Microwave Associates, it's now easier than ever to put together a practical station for amateur operation on the 10-GHz band. Only a few years ago a "simple" microwave setup required a rack-full of equipment and friends in the industry who could provide hard-to-find parts. With the Gunnplexer, an entire microwave system can now be held in one hand. It can be easily backpacked to the highest mountain tops, and it can be operated from a single 12-volt battery.

As you receive it, the Gunnplexer module is not a complete transceiver; to put it on the air you need a dc power supply, a simple speech amplifier, and an fm receiver. You can put together a working system in one evening. To build a complete transceiver like that described in this article will take a little longer.

what is a gunnplexer?

The heart of the Gunnplexer is the Gunn diode oscillator, named after the IBM engineer who invented it in 1963, John Gunn. While measuring the resis-

By James R. Fisk, W1HR, *ham radio*, Greenville, New Hampshire 03048
tance of gallium arsenide (GaAs), Gunn found that when the voltage across a thin wafer of the material was increased above a certain point, the current fluctuated at microwave frequencies. The mechanism which caused this was a mystery at first, but Gunn suspected a negative resistance due to electron movements within the gallium arsenide. This eventually proved to be the case (a detailed description of the Gunn diode phenomenon is contained in reference 1).

When a Gunn diode is placed in a resonant microwave cavity, small amounts of power can be obtained at the desired frequency. The cavity can be tuned mechanically, or a voltage-variable capacitor (varactor) may be used to change the resonant frequency of the cavity. The Gunnplexer (fig. 1) uses both a mechanical tuning screw and a varactor diode; frequency modulation is obtained by placing a small modulating voltage across the varactor. Power is coupled out of the cavity through an iris. The size of the iris must be determined experimentally for the best compromise between maximum power output and isolation from changes in diode impedance and load.

In the Gunnplexer the Gunn oscillator provides both the transmit power and the local-oscillator injection for the mixer diode. The ferrite circulator couples a small amount of energy into the low-noise Schottky mixer diode and isolates the transmit and receive functions. Since the Gunn oscillator functions as both the transmitter and receive oscillator, the i-f receiver at each end of the communications link must be tuned to the same frequency, and the frequencies of the Gunn oscillators at each end of the link must be separated by the i-f.

Confused? Take a look at fig. 2. Here Gunnplexer 1 is tuned to the center of the 10-GHz amateur band at 10250 MHz. If a 30-MHz i-f receiver is used, Gunnplexer 2 must be tuned either 30 MHz higher or lower than Gunnplexer 1. Assume it’s tuned 30 MHz higher at 10280 MHz, its signal will mix with the 10250-MHz LO in Gunnplexer 1 to provide an output to the receiver at 30 MHz. Conversely, the 10250-MHz transmit signal from Gunnplexer 1 will mix with the 10280-MHz LO in Gunnplexer 2 to provide an output at 30 MHz.

**gunnplexer communications range**

One of the first and most asked questions about Gunnplexers is, what is their maximum range? Since most microwave communications systems are based on line-of-sight transmission, it’s a relatively easy matter to determine the effective communications range of any Gunnplexer system. When the distance between the two stations is known, path loss in dB is given by:

\[
92.5 \, \text{dB} + 20 \log f \, (\text{GHz}) + 20 \log D \, (\text{kilometers})
\]

\[
96.6 \, \text{dB} + 20 \log f \, (\text{GHz}) + 20 \log D \, (\text{miles})
\]

where \( f \) is the operating frequency and \( D \) is the distance between transmitting sites. Note that each time the frequency is doubled, the path loss increases by 6 dB. This is shown graphically in fig. 3, which shows the path loss vs distance for each of the amateur bands above 1000 MHz. At 10250 MHz, the center of the 10-GHz amateur band, the path loss equation can be simplified to:

\[
112.7 + 20 \log D \, (\text{kilometers})
\]

\[
116.8 + 20 \log D \, (\text{miles})
\]
In other words, the path loss over a distance of 1 km is 112.7 dB; it increases 6 dB each time the path length is doubled. The objective is to build enough gain and sensitivity into the microwave system to overcome the loss over the desired path. This is a function of transmitter power, antenna gain, receiver sensitivity (noise figure), and receiver bandwidth, but it’s not as complicated as it sounds because all these factors can be easily translated into dB.

The graph of fig. 4 has been designed to simplify the calculation of communications range at 10250 MHz and is normalized to a power output of 15 mW, receiver bandwidth of 200 kHz, 12-dB noise figure, and 17-dB gain antennas at each end of the link. This is what I consider a minimal Gunnplexer system. The horizontal line labelled THRESHOLD is the beginning of reception of intelligible speech and allows no margin for fading due to rainfall, multipath propagation, or other environmental effects. With the minimal Gunnplexer system, threshold occurs at a distance of about 127 kilometers (76 miles). Since a carrier-to-noise ratio of 8-10 dB is recommended for reliable communications, about one-third this distance could be used for successful communications.

There are four major things which can be done to increase range: use higher transmitter power, reduce receiver bandwidth, improve receiver sensitivity, or increase antenna gain. The effects of power output and receiver bandwidth are shown in the chart on fig. 4. Each improvement in system performance adds the stated number of dB to the carrier-to-noise ratio. A 40-mW Gunnplexer with a receiver bandwidth of 25 kHz, for example, improves the carrier-to-noise ratio by 13.3 dB (4.3 dB for 40 mW transmitter power, plus 9.0 dB for reduced bandwidth). This system would provide a carrier-to-noise ratio of 8 dB at a line-of-sight distance of 233 kilometers (145 miles).

When calculating the communications range of a microwave system, all the gain and loss components of the system must be considered, as shown in fig. 5. Here a distance of 50 km (30 miles) is assumed, so the path loss is 146.7 dB. The other item which is fixed is the thermal noise floor, at -144 dBm, which is set by the laws of nature and determines the ultimate sensitivity of the receiver.

Beginning at the transmitting end of the link, we have 15 mW power output (+11.8 dBm). To this is added the 17-dB gain of the antenna. When the path loss is subtracted, the signal level at the receiving site is -117.9 dBm. The 17-dB-gain receiving antenna increases the signal to -100.9 dBm. From this must be subtracted the 12-dB noise figure and the 200-kHz bandwidth factor (23 dB), for a signal level of -135.9 dBm. The difference between this and the thermal noise floor at -144 dBm is the carrier-to-noise ratio. For this link, +8.1 dB.

The easiest way to improve range is to use a higher
fig. 4. Carrier-to-noise ratio vs distance for two 15-mW Gunnplexers at 10250 MHz, equipped with 17-dB-gain horn antennas; receiver noise figure is assumed to be 12 dB with 200 kHz bandwidth. The THRESHOLD line is the beginning of the reception of intelligence. At a distance of 127 km (76 miles) the carrier is at the noise level or threshold; at a distance of about 40 km (25 miles) the carrier-to-noise ratio is 10 dB, the minimum signal level recommended for reliable voice communications. Range can be lengthened by increasing transmit power, decreasing bandwidth, or adding antenna gain (see text). Improvements in dB for increased output and narrower bandwidth are shown.

gain antenna. Unlike the lower frequencies, where antenna gain is hard to come by, on the microwave bands it’s relatively easy. A 24-inch (61-cm) parabolic reflector, for example, yields 32 dBi gain. If used at only one end of the system shown in fig. 5, this would have the effect of increasing the range to nearly 2000 km (1200 miles) for the same 8.1 dB carrier-to-noise level! That’s obviously well beyond line-of-sight for any two earth-based locations. One disadvantage of high antenna gain is antenna alignment; the 4-degree beamwidth of a 24-inch dish leaves little room for error when pointing the antenna at another station.

You can also increase range by reducing the bandwidth of your receiving system, but because of the thermal drift of the Gunnplexer, this requires a system which phase locks the Gunn oscillator to a crystal-controlled reference oscillator. The cost of a phase-locked system is somewhat less than that of a commercial parabolic reflector, but system gain is only on the order of 12-13 dB when compared with a system with 200-kHz receiving bandwidth. On the other hand, a phase-locked system permits the use of CW, which provides reliable communications with lower carrier-to-noise ratios than voice, so there may be the equivalent of an additional 4-5 dB gain available.

For greater range you can also increase transmitter output or improve receiver noise figure, but both are expensive and limited to a certain extent by the present state of the art.

gunnplexer performance

The Gunnplexer performance measurements discussed here were made by B. Chambers, G8AGN, of the Department of Electronic and Electrical Engineering at the University of Sheffield, England, who is also a member of the Microwave Committee of the Radio Society of Great Britain. Front-end performance was not measured because, in practice, receiver sensitivity and noise figure are highly dependent on the operator’s choice of i-f strip and the degree of matching between the mixer diode and the i-f preamplifier. Therefore G8AGN made measurements only to check the performance of the Gunn oscillator.

When a variable voltage was connected to the Gunn diode, it was found that rf power was produced with an applied voltage as low as 5 volts. Most of the tests, however, were accomplished with +10 volts applied to the Gunn diode and +4 volts bias on the varactor diode.

Using a Systron-Donner model 6057 frequency counter with an upper frequency limit of 18 GHz, G8AGN found that the Gunn oscillator drifted down in frequency by about 3 MHz during the initial one-hour warm-up period. A further frequency check 15
minutes later showed that the oscillator was drifting down in frequency by about 28 kHz per minute. This rate of drift is quite acceptable in practice unless a narrow-band system is being used and there is no provision for AFC.

The mechanical tuning range of the oscillator was checked next and found to extend from 9641 MHz up to 10764 MHz. The rf power output over this frequency range was measured with a Marconi model 6460 power meter with a coaxial head, buffered by a fixed 20-dB pad. This was preceded by a coax-to-waveguide transition and slide-screw tuner which was adjusted before each reading to ensure that the oscillator was delivering power into a matched load. Fig. 6 shows the variation of rf output power over the frequency range from 10.0-10.5 GHz. Rf power measurements at the extremities of the tuning range showed 39 mW at 9641 MHz and 24 mW at 10764 MHz.

For a given setting of the mechanical tuning screw, the frequency of the Gunn oscillator may be tuned electrically by changing the voltage applied to either the Gunn diode or the varactor. Varying the voltage of the Gunn diode over the range from +5 to +11 volts produced a frequency change of 13.3 MHz about a preset value of 10250 MHz. This represents approximately 2.2 MHz per volt for frequency pushing and is well within the quoted specification.

With the Gunn diode held at +10 volts, the varactor bias was varied from +1 to +12 volts and measurements were made of both frequency and rf power output. Although up to +20 volts bias may be used on the varactor, measurements were made only to +12 volts because this is the maximum voltage usually available for portable operation. Fig. 7 shows the result of these measurements. It can be seen that the maximum electronic tuning range was approximately 100 MHz, and that over this range the rf power output varied by about 3.5 dB.

The final set of Gunnplexer measurements made by G8AGN were concerned with the frequency-pulling performance of the Gunn oscillator. To make these measurements, the Gunnplexer was set up to deliver power to a load consisting of an adjustable short circuit; therefore, by varying the axial position of the short-circuit plane within the waveguide, a wide range of load impedances would be seen by the oscillator. For an axial variation of the short-circuit plane of 20 mm (0.8 inch), corresponding to a distance just greater than $\lambda/2$ at 10250 MHz, the total frequency variation was found to be 12 MHz.

The result of this test suggested that the ferrite circulator should be "transparent" enough for the Gunnplexer to be frequency locked using a cavity wavemeter, and this, in fact, proved to be the case. A $TE_{011}$ mode transmission-type cavity wavemeter with a quoted $Q$ factor of 8000 was available. This was simply bolted to the Gunnplexer assembly—the resulting separation between the wavemeter and the coupling iris to the Gunn oscillator being about 6.5 cm (2.6 inches). The wavemeter cavity had provision for attaching a waveguide diode holder, and this was

---

**fig. 6.** Typical variation of Gunnplexer output power as the frequency is tuned mechanically through the 10-GHz amateur band, as measured by G8AGN. At all frequencies the output was well above the rated 25 mW.

**fig. 7.** Frequency variation and measured power output with changes in varactor bias, as measured by G8AGN. Power output varies less than 3.5 dB over the nearly 100-MHz tuning range.
used in conjunction with a sensitive milliammeter to detect when the cavity was tuned near resonance.

With a little practice, GBAGN found that it was possible to hold the frequency of the Gunn oscillator to within 1 kHz for periods of minutes at a time. In view of this, it seems probable that the Gunnplexer could also be injection locked using a crystal controlled source, although this was not tried.

**power supply**

The first requirement for a Gunnplexer system is a regulated +10 volt power supply. Unfortunately, there aren't any readily available, high-current, three-terminal IC regulators with a 10-volt output (the Lambda LAS1510 meets these requirements, but is difficult to purchase in small quantities). The answer is the Fairchild µA78MG 4-terminal regulator, which requires only two external resistors to set the regulated output voltage (see fig. 8). This regulator will provide in excess of 500 mA output, so it's adequate for most Gunnplexer systems.

For precise voltage adjustments, I have included a miniature 500-ohm pot between the two 4700-ohm resistors; this allows the output voltage to be set within a few millivolts of +10 volts. If you're not this fussy, you can connect the IC's control terminal (pin 4) directly to the junction of two 4700-ohm resistors — the output voltage should be within 5 per cent of the required 10 volts. This is probably close enough for most applications.

In many circuits using the µA78MG regulator the bypass capacitors may not be required. However, for stable operation of the regulator IC over all voltage and current input ranges, bypassing is recommended by the manufacturer (0.33 µF at the input and 0.1 µF at the output). The input bypass is necessary if the regulator is located far from the filter capacitor in the power supply; bypassing the output improves the transient response of the regulator.

**tuning range**

The frequency of the Gunnplexer is controlled by

![fig. 8. Regulated Gunnplexer power supply can be adjusted to exactly +10 volts; with proper heatsinking, this circuit will provide current in excess of 500 mA. The 0.33-µF capacitor at the input and 0.1 µF at the output improve circuit performance.](image)

the voltage on the built-in tuning varactor, the setting of the mechanical tuning screw, and the supply voltage to the Gunn diode. Unless otherwise specified, the Gunnplexer is mechanically tuned to 10250 MHz at the factory with 10.0 volts on the Gunn diode and 4.0 volts across the varactor. The output frequency of the Gunnplexer can be adjusted ±100 MHz with the tuning screw, but I don't recommend touching the mechanical tuner unless you have access to a microwave frequency counter; you will find it difficult to accurately retune the unit to 10250, the center of most amateur activity on this band.

The Gunnplexer can also be electronically tuned by varying the voltage across the varactor from 1 to 20 volts; this is the preferred method, and a tuning range of 60 MHz is guaranteed. Electronic tuning range varies from unit to unit, but data is furnished with each Gunnplexer so you can easily estimate frequency output vs varactor voltage. Many units have an electronic tuning range of 100 MHz or more, so it's not necessary to touch the mechanical tuning screw for most amateur applications.

Shown in fig. 10 is a plot of frequency output vs varactor tuning voltage for a 40-mW Gunnplexer that I am using at my station. The tuning curve is quite nonlinear, with the greatest frequency change — 50 MHz — occurring as the varactor voltage is increased from 1 volt to 4 volts. An increase from 4 volts to 10 volts moves the output frequency up 40 MHz, and a change from 10 volts to 20 volts increases the output frequency 46 MHz. The total frequency change is 136 MHz. The tuning range of other Gunnplexers won't exactly follow this curve, but it gives you an idea of what you can expect.

The varactor also provides a way of frequency modulating the unit. If a small modulating voltage is

*Shortly after this article was written, Fairchild Semiconductor announced the µA78C00 series of 3-terminal voltage regulators which have rated output current greater than 500 mA. A 10-volt regulator, the µA78C10C, is included in the series.*
impressed on the varactor bias, the frequency will be varied at an audio (or video) rate. Because of the wide electronic tuning range, the required modulation voltage is very small; 10 mV or so for 75 kHz deviation, or less than 1 mV for 5 kHz deviation. However, don’t plan on using narrowband deviation unless you have a crystal-controlled, phase-locked system for stabilizing the Gunnplexer frequency.

The output frequency also varies with changes in the Gunn diode supply voltage — 15 MHz per volt maximum — but this isn’t recommended as a tuning method. In addition, the power output and efficiency of the Gunnplexer has been optimized for a 10.0-volt supply, and you don’t want to risk damaging the expensive Gunn diode.

In portable systems designed to operate from +12 volts, it’s convenient to set the maximum varactor voltage at the +10-volt Gunn diode supply. This provides more than enough tuning range if you use a 30-MHz i-f system. Amateurs in Europe usually transmit voice on 10250 MHz and receive on 10280 or 10220; in the United States many stations have standardized 10250 for transmitting and 10280 for receiving (for full duplex operation one station transmits on 10250 and the other transmits on 10280).

If you use fm broadcast receivers at each end of the link with a 10-volt varactor supply, you may not be able to obtain sufficient tuning range to cover the required 100 MHz. However, if you use an auxiliary varactor supply that will provide up to 20 volts, you should have no difficulty obtaining the required range. In many cases the nominal 12 volts available from an automobile battery will be sufficient. If you use an ac-powered dc supply for the varactor, however, be sure it’s well regulated and filtered. Any ripple on the supply line will result in hum modulation.

**varactor bias control**

Since small changes in varactor bias have a large effect on the output frequency, a multi-turn potentiometer should be used for the tuning control (with a conventional 270° pot, the frequency can change 300 kHz or more for each 1 degree rotation of the pot’s shaft). Sometimes you can find precision 10-turn pots on the surplus market, but, if not, there are several alternatives. One is to use a single-turn pot with a reduction unit like the Jackson Brothers 6:1 planetary drive. This may not be completely satisfactory, however, because resolution may be limited by man-
Minimal Gunnplexer system used by W1HR includes a 10-volt IC voltage regulator, simple speech amplifier, and tone oscillator. A phono connector on the bottom of the chassis is provided for the FM receiver. A 10-turn precision potentiometer found on the surplus market is used for frequency control.

Manufacturing tolerances in the potentiometer's resistance element.

Two other possibilities for varactor control are shown in fig. 11. The system in fig. 11A uses one dual potentiometer for coarse adjustments and a single-turn pot for fine tuning. Resolution of this system is about four times better than with a 10-turn pot and is suitable for the most demanding requirements. The bias control arrangement in fig. 11B does not provide as much resolution but is more economical. A disadvantage is that the resolution of the fine adjustment varies, and depends upon the setting of
the coarse control; when the coarse potentiometer is in the center of its range, resolution approximates that of a 10-turn pot.

speech amplifiers

Because of the high sensitivity of the varactor, a very small modulation voltage (on the order of 10 mV p-p) is required to obtain 75-kHz deviation for wide-band frequency modulation of the Gunnplexer; this greatly simplifies the design of a suitable speech amplifier. In its simplest form, the Gunnplexer speech amplifier requires only one transistor, as shown in fig. 12A. In this circuit the MPF102 fet exhibits high input impedance for a crystal, ceramic, or dynamic microphone, and provides more than enough voltage gain for full 75-kHz deviation at 10.25 GHz. Deviation is adjusted with the 10k potentiometer in the drain circuit.

The two-transistor speech amplifier in fig. 12B has an input impedance of about 20 kilohms and includes filtering to limit the speech bandwidth. For those who prefer to use ICs, the circuit in fig. 13 is recommended. This 741 speech amplifier was designed by G8AGN/G8CZO for use with a Gunn diode transmitter.

In any frequency-modulation system the speech amplifier should, in addition to providing audio gain, include some form of speech processing to limit dynamic range so the audio signal doesn't exceed the maximum frequency deviation. This can be done with audio compression or by using a simple diode clipper to limit the audio peaks. The two-stage speech amplifier shown in fig. 14 includes a clipper and lowpass RC filter (47k resistor and 0.02-μF capacitor) to reduce the harmonics produced by clipping. I used 2N2222 transistors in this circuit because I had them in my junk box, but most high-gain NPN transistors should work. If you wish, the same diode clipper and RC filter can be added to the circuits of figs. 12 and 13.

For most effective fm communications, the speech system should include a system for limiting bandwidth to 300-3000 Hz, and de-emphasis to correct the speech frequency characteristic. A circuit which...
has a complete speech amplifier, clipper, active filter, and de-emphasis stage is shown in fig. 15. The first two stages use heavy feedback to reduce distortion and improve frequency response. These stages are followed by a double-diode clipper and a two-stage active filter that has a 500-3000 Hz passband. The last stage provides de-emphasis. This amplifier gives an output of 100 mV for an input of 2 mV across 300 ohms; both input and output controls are provided. I have used this amplifier with good success at one end of a wideband Gunnplexer link.

tone oscillator

When lining up two Gunnplexer systems, particularly if you're using high-gain parabolic reflectors, it's helpful to continuously tone modulate your transmitter. There are several ways to generate an audio tone, but for minimum parts count I prefer the circuit of fig. 16, which uses a 555 timer IC. Total current drain with a 10-volt supply is only 10 mA. The 1-kHz squarewave output swings from ground to +10 volts; this is reduced to manageable levels for Gunnplexer use with the series 100k resistor and 200-ohm pot. The 10k resistor and 0.1-μF capacitor form a lowpass filter; in some applications the filter may not be required.

If you have a memory keyer, it can be plugged into the key jack and used to send your call sign, a series of vees, or your location. If you wish to send only your call sign, you might consider the automatic CW ID unit manufactured by Autocode.* Although this unit was designed for automatically sending CW identification for RTTY or vhf-fm transmissions, it is ideal for Gunnplexer systems.

i-f receiver

Although a 30-MHz i-f receiver is recommended if you want to work reliably over long distances, to get started with a Gunnplexer system many amateurs have used low-cost fm broadcast receivers tuned around 100 MHz. One popular unit is the Audiovox fm converter; this receiver sells for less than $20, can be completely converted to Gunnplexer use in one evening, and is a good compromise unit for getting started on 10 GHz with Gunnplexers. Complete conversion information is available from G. R. Whitehouse & Company.† The main disadvantage of an fm broadcast receiver is i-f feedthrough. For best results you must pick a frequency that is clear of local fm broadcasters. If you take this system mountain-topping, your problems with i-f feedthrough will increase dramatically, but it is still a good way to get started. Also, it's a simple matter to add a better receiver to your system later — no other parts of the set-up will have to be changed.

Another low-cost approach to the i-f receiver can be found in the used two-way equipment market. Many of the fire, police, and public-service fm receivers built 10 or more years ago can now be purchased for a few dollars. The receiver you want for Gunnplexer use was originally designed to tune from 30 to 50 MHz and is built for wideband fm. Many of the newer fm receivers for this band are for narrow-band fm, so they are not suitable for Gunnplexer use. A number of companies marketed solid-state receivers of this type in the 1960s, including Lafayette, Radio Shack, and Regency. Some had provisions for crystal control; this, if you can find one, is the type most suited to Gunnplexer communications. Price for a receiver of this type is typically around $5; most users have switched to more portable narrow-band receivers with scanners, so the older, tunable receivers have practically no commercial value.

*Autocode, 8116 Glider Avenue, Dept. H, Los Angeles, California 90045.
†G. R. Whitehouse stocks 15-, 25-, and 40-mW Gunnplexers; his address is Newbury Drive, Amherst, New Hampshire 03031.
fig. 18. Gunnplexer AFC system designed by DJ700 for use with his 30-MHz fm receiver. Circuit may be adapted to other fm receivers by changing the ratio of resistors R1 and R2. It may be desirable in some cases to replace R3 with a trimmer pot. In the center position of switch S1, the AFC is turned off, the two outer positions provide positive- and negative-going AFC voltage with increasing frequency (see text).

The choice of 30 MHz for the i-f receiver means that you can set up your Gunnplexer on 10250 MHz and tune in stations either 30 MHz above or below your center frequency. Many Gunnplexers don't have sufficient electronic tuning range to handle an i-f at 100 MHz with only +10 volts of varactor bias. If you have a +20 volt bias supply available, many Gunnplexers will tune the required 100 MHz, but that precludes most portable operation unless you provide additional batteries for the bias supply. For reasons mentioned previously, I don't recommend touching the mechanical tuning screw.

I have used both tunable and crystal-controlled 30-MHz i-f receivers in Gunnplexer links, and the difference is like night and day. Tunable receivers are fine if you're interested in working over short distances, but if you want to communicate farther than you can shout, you have to use a crystal-controlled i-f receiver. Remember that the local oscillator for your receiver is the Gunn oscillator at the other station; for communications, the receivers at both ends of the link must be tuned to exactly the same frequency. Even at 30 MHz, a tunable receiver that is off frequency by only 1 per cent will be completely out of the passband of a wideband fm signal.

Automatic Frequency Control (AFC) is helpful when you first turn on your Gunnplexer, but if both stations are operating in essentially the same environment, I've found that frequency drift during warm-up is slow enough that it's an easy matter to keep the other station tuned in. Once the two Gunnplexers have reached thermal equilibrium, they'll sit on frequency for hours at a time.

The receiver I'm using in my Gunnplexer station was described by DJ700.5 In addition to being crystal controlled, it has built-in provisions for a tuning meter and signal strength meter; both are extremely useful in setting up Gunnplexer links over marginal paths. Also, the output from the discriminator is available for AFC purposes. If you're interested in serious microwave communications, I highly recommend this receiver.

As supplied, the DJ700 receiver is built into a tinned-steel enclosure with no mounting tabs. If you wish, small L-shaped brackets could be soldered to the enclosure, or the receiver could be clamped into place. In my Gunnplexer transceiver I mounted the DJ700 receiver with spacers and long screws; this seems to be more rugged than brackets or clamps, and, since the transceiver is designed for portable use, I wanted something that would stand up to unintentional abuse (see fig. 17).

If you purchase a DJ700 i-f receiver, the only problem you may have is obtaining knobs to fit the potentiometer shafts. The diameter of these shafts is 4 mm — too large for 1/8 inch shafts, and too small for 1/4 inch! The best solution is to purchase knobs for 1/8 inch shafts and drill them out with a no. 22 or 4 mm drill. You can also wind tape around the shafts to build them up to 1/4 inch, but the knob will tend to feel sloppy and will probably be eccentric.

**Automatic frequency control**

After a Gunnplexer is initially turned on, its output frequency drifts rapidly as the unit warms up. The typical drift rate is about 300 kHz per degree Celsius, and since the Gunnplexer temperature may go up 10 degrees per minute after it's first turned on, total frequency drift is 3 MHz or more. As the unit reaches thermal equilibrium, however, frequency drift slows, and, if the unit is shielded from wind currents, the output frequency is quite stable. If the Gunnplexers at opposite ends of a wideband fm communications link ($\Delta f = 200$ kHz) are in similar environments, they can be used for voice communications over long periods of time without any frequency adjustments.

fig. 19. Receiver passband showing upward frequency drift of Gunnplexers operating above (A) and below (B) a Gunnplexer with AFC. To maintain the received signal in the center of the passband requires AFC with positive sense in (A) and negative sense in (B).
fig. 20. Circuit for a Gunnplexer transceiver without a built-in i-f receiver. In the original model, this circuit was built on perf board. Resistor R1 is adjusted for the desired tone level; R2 is set for a 1-volt drop.

(After an initial warmup of 30 minutes, two enclosed Gunnplexers in my shop remained on channel for more than a day.)

For closer frequency control you can either preheat the Gunnplexer (or use a proportional temperature control system as I suggested in an earlier article) or use automatic frequency control (AFC). Gunnplexer temperature control would probably be a good choice for use at a base station, but because of the huge current drain of any heating system, AFC is better for portable use. In an AFC system any deviation in the average value of the i-f from the center frequency of the discriminator in the receiver will produce a dc voltage determined by the direction of the frequency deviation. This dc voltage is applied to the varactor in the Gunnplexer to bring it back on frequency. Note that the use of AFC must be limited to one end of a Gunnplexer link; the other end is allowed to run free.

In many cases, the AFC voltages for the Gunnplexer can be obtained from the i-f receiver. The AFC system shown in fig. 18 was designed by DJ7OO for use with his 30-MHz receiver. This same basic circuit can be used with other fm receivers by simply changing the values of resistors R1 and R2. In some cases the circuit will work as shown, but others will require more (or less) gain — which is set by the ratio of R1 to R2. The only other adjustment is R3, which should be set for a voltage drop of 1 volt.

In the center position of switch S1 the AFC is turned off; the two outer positions provide positive- and negative-going AFC voltage with increasing frequen-

fig. 21. Complete Gunnplexer transceiver featuring high-performance speech amplifier with clipping and de-emphasis, crystal-controlled 30-MHz receiver, and low-noise preamplifier.

A circuit board for the speech amplifier, tone oscillator, AFC system, and regulated power supply is shown in fig. 22.

The choice of which is chosen depends upon whether the frequency of the Gunnplexer with AFC is above or below the free-running Gunnplexer without AFC. Assume the Gunnplexer with AFC is set to 10250 MHz (see fig. 19). If the free-running Gunnplexer is at 10280 MHz and drifting higher, the incoming signal is moving upward through the receiver passband. Therefore, a positive AFC voltage is required to shift the 10250-MHz LO up to recenter the 10280-MHz signal on the middle of the passband. If the free-running Gunnplexer drifts downward, the opposite occurs. In either case, however, the sense of the AFC voltage is the same (positive) as the necessary frequency shift.

Now consider what happens if the free-running
Wideband 30-MHz fm receiver designed by DJ700 for use with Gunnplexer systems (described in the August, 1978, issue of *ham radio*). At the left is the mosfet input stage, followed by the S042P crystal-controlled local oscillator and mixer, TDA1047 i-f strip, and TAA611 audio power amplifier. The two controls are for squelch and audio gain.

Gunnplexer is below the one with AFC at 10220 MHz. If it is drifting higher, the incoming signal is moving down through the receiver passband, and a negative AFC voltage is required to move the 10250-MHz LO down to shift the 10220-MHz signal to the center of the passband. Therefore, if the frequency of the Gunnplexer with AFC is above that of the free-running Gunnplexer, the sense of the AFC voltage is opposite (negative) to the necessary frequency shift.

Obviously, the sense of the AFC voltage is extremely important. If the AFC sense is incorrect, it tends to chase the received signal out of the passband. In fig. 19B, for example, if positive AFC is used, upward drift toward 10221 MHz will reduce the AFC voltage, moving the LO toward 10249 MHz — the wrong direction! If the AFC has the wrong sense, you’ll find it almost impossible to tune in the signal; in many cases the LO will actually oscillate back and forth across the receiver passband several times per second. If you’ve built a Gunnplexer system with AFC and have experienced this problem, now you know what caused it.

**gunnplexer transceivers**

To build a complete Gunnplexer transceiver, all you have to do is combine some of the previous circuits and build them into a single enclosure. Two examples are shown in the accompanying photographs. The first, which I call the "minimal" Gunnplexer system, is built into a 125 × 100 × 75 mm (5 × 4 × 3 inch) Minibox and doesn’t include the receiver (a phono jack is provided so it can be used with a variety of external receivers). The other transceiver, which is built into a 225 × 150 × 125 mm (9 × 6 × 5 inch) aluminum utility box, includes a built-in 30-MHz receiver with a low-noise preamp and speaker.

The circuit of the minimal Gunnplexer transceiver is shown in fig. 20. Basically, it consists of the two-transistor speech amplifier (fig. 14), 1000-Hz tone oscillator (fig. 16), and regulated dc power supply. Note that the lowpass filter at the output of the tone oscillator is combined into the speech amplifier. No receiver was included because at the time I built this transceiver I was still undecided about a receiver and wanted to try several options. Since it was built it has been used successfully with a variety of i-f receivers at 30 MHz, 100 MHz, and, more recently, 111 MHz (the New England spot for retuned fm broadcast receivers).

The Gunnplexer transceiver shown in fig. 21 might be called the "deluxe" model. In addition to the built-in 30-MHz receiver and low-noise preamp, it features the high-performance speech amplifier with clipping, audio shaping, and de-emphasis (fig. 15),

10-GHz Gunnplexer system setup by the W1FC group on Pack Monadnock in New Hampshire during the September vhf/uhf contest. Two-way communications were established with Gunnplexer-equipped stations in Maine, New Hampshire, and Vermont.
fig. 22. Component layout for the printed-circuit board for the Gunnplexer transceiver. At the top of the board is the speech amplifier with clipping and de-emphasis. Below, right to left, are the 555 tone oscillator, 741 AFC amplifier, and 78GU1 voltage regulator. (Note that the 78GU1 is mounted on the foil side of the board.) In the speech amplifier, pot R1 sets the microphone gain; pot R2 is used to set maximum deviation. Pot R3 sets the tone voltage level into the speech amplifier; R4 is the +10 volt adjust, and R5 is set for +1 volt at TP1. The capacitors in the audio amplifier are tantalum types.

an AFC system, tone oscillator, and regulated power supply. To save space and improve reliability, these circuits are built on a printed-circuit board (fig. 22). For improved heatsinking of the 78GU1 voltage regulator, this IC is mounted on the foil side of the circuit board. In addition, an aluminum mounting spacer is used to conduct heat to the chassis. The result is a very cool-running voltage regulator, even with 500 mA of output current. In the transceiver this circuit board is mounted on the rear wall of the utility box. A 100 × 100 mm (4 × 4 inch) aluminum plate, 6 mm (1/4 inch) thick, is mounted in the bottom of the enclosure and tapped for a 1/4-20 screw. This is the standard thread for camera tripods sold in the United States.

When setting up this transceiver, first set the 500-

fig. 23. Full-size printed-circuit layout for the Gunnplexer speech amplifier, tone oscillator, AFC amplifier, and voltage regulator. Component layout is shown in fig. 22.

*Complete parts kits, including PC board, are available from G. R. Whitehouse, 10 Newbury Drive, Amherst, New Hampshire 03031.

ohm voltage adjust potentiometer, R4, for +10.0 volts at the Gunn diode, then adjust R5 for 1.0 volt at test point 1 (TP1). The tone output level adjustment, R3, is set for the same deviation as the microphone; this and the other audio adjustments are discussed later.

january 1979
Head-on view of the Gunnplexer showing the mixer diode, left, and ferrite circulator (black cylinder to right). The small screw which protrudes through the top of the waveguide is used to adjust mixer injection.

One feature of the transceiver which is not shown on the schematic should be mentioned: a small relay to turn off the speaker during voice transmissions. When communicating with a Gunnplexer system, the receiver detects both the signal from the distant station and the local transmitted signal. In addition to being annoying, this is sometimes the cause of unwanted howls and squeals because of audio feedback. To solve this problem, some builders have installed a spdt switch to transfer the audio output to a 4.7-ohm resistor. In my transceiver I installed a miniature spdt relay which is operated by the PTT switch on the microphone (most 12-volt relays work quite well on +10 volts). The speaker circuit isn’t affected when the tone oscillator is used for CW, so I have a built-in CW sidetone system.

waveguide flange layout

If you wish to mount your Gunnplexer inside an aluminum Minibox, you must match the waveguide and mounting screws to a cutout in the enclosure. There are feedthrough waveguide flanges on the market, but they’re expensive and seldom make their way into the surplus market. The only alternative is to carefully lay out the mounting holes for the UG-39/U waveguide flange and then hand file a cutout to match the interior dimensions of the waveguide. This is difficult if you don’t have access to a waveguide handbook because the screw holes are not at the corners of a square, as you might suppose, but are slightly offset as shown in fig. 24. This is done intentionally so it is impossible for a technician to cross polarize sections of waveguide.

To locate the mounting holes for the UG-39/U flange, prick punch the center and use a compass to swing an arc with a radius of 15.5 mm (0.61 inch) as shown in fig. 24B. Now use a carpenter’s or machinist’s square to draw two vertical lines which are tangent to the arc (fig. 24C). Using the same center point, swing another arc with a radius of 16.3 mm (0.64 inch) and use the square to draw two horizontal lines (fig. 24D). The screw mounting holes are located at the intersections of the straight lines. To check their location, swing an arc with a radius of 22.5 mm (0.884 inch); it should cross the center point of each of the hole locations (fig. 24E). When you are satisfied that the mounting holes are correctly located, drill the holes with a number 18 (4.3 mm) drill for the 8-32 mounting screws. Temporarily mount the Gunnplexer to make sure the holes mate with the tapped holes in the Gunnplexer flange.

After the screw holes have been located you can make the rectangular cutout for the waveguide. This cutout measures exactly 0.4 to 0.9 inch and is centered on the same point as the mounting holes. After scribing the outline with a square, I found the best approach was to drill out the center point with an 8 mm (5/16 inch) drill. This provides clearance for an Adel nibbling tool.

A word of warning: don’t try to make the finished cutout with the nibbler; you’re sure to botch the job. Use the nibbler only to make the rough cutout — within about 1 mm (1/32 inch) of the finished edge. Then carefully hand file the edges of the opening so they match the waveguide.

Temporarily install the Gunnplexer to check progress, but carefully wipe off the metal filings first so

Microwave Associates 10-GHz Gunnplexer and 17-dB horn antenna. Receiver section is housed in waveguide section machined from large block of metal. This improves thermal stability of the unit.
they don’t get into the Gunnplexer. And don’t leave the Gunnplexer in place while you’re filing the openings — that’s an open invitation to disaster!

**set up and test**

The easiest way to set up a Gunnplexer system is to get together with a friend and set up your 10-GHz stations at the same time. With two Gunnplexers running on the bench, it takes only a few minutes to adjust the speech amplifier and tone oscillator for best performance. Tests and adjustment of an AFC system take longer, but most work can be done in one evening.

The only problem you’re apt to encounter with two Gunnplexers in the same workshop is high signal strength — if you have an S-meter, you can be sure it will be against the pin, regardless of the direction you point your Gunnplexers. However, wood makes an excellent microwave absorber, as does the conductive black plastic foam which is often used to protect CMOS integrated circuits. A small section of black foam placed across the waveguide will reduce the radiated signal by 30 dB or more; a section of 2 x 4 pine lumber in front of the Gunnplexer reduces signal strength by 10 or 12 dB. Once you have reduced signal strength to manageable levels, you can make the necessary adjustments. First set one Gunnplexer up with +10 volts on the Gunn diode and +4 volts on the varactor; unless tuned specially by the manufacturer, the operating frequency will be close to 10250 MHz. Now tune the other Gunnplexer to a frequency below the first where you hear the carrier, and carefully adjust the varactor bias for a zero reading on the carrier meter (if your receiver doesn’t have a zeroing meter, adjust for maximum signal strength). Make a note of the varactor voltage; this Gunnplexer will now be tuned to 10220 MHz if a 30-MHz i-f is being used.

Now tune the second Gunnplexer above the first until you hear the carrier and carefully center the carrier in the passband of the receiver. Make a note of the varactor voltage (Gunnplexer tuned to 10280 MHz with a 30-MHz i-f). If you wish, you can now set the varactor voltage on this Gunnplexer to +4 volts and make similar measurements on the other unit. If you use a turns-counting dial on the varactor bias

---

**fig. 24.** How to lay out the chassis to match a UG-39/U waveguide flange (used on all Microwave Associates Gunnplexers). Note that the flange holes are not symmetrical. Step-by-step instructions are given in the text.
potentiometer, it’s helpful when mountain-topping to know which dial settings correspond to the operating frequencies of 10220, 10250, and 10280 MHz.

Now tune the Gunnplexers to one another and carefully center the carriers. Plug in your microphone and increase the speech gain control. You will note that the received audio signal will have excellent fidelity at a certain setting of the gain control, but, as gain is increased beyond that point, the signal becomes distorted. Back down the gain control to a setting slightly below that which causes audible distortion.

If you wish to measure the actual deviation of your signal, you can use the Bessel function relationship to determine the audio input frequencies at which the fm carrier will completely disappear; this technique is discussed in most of the popular vhf-fm books. Table 1 lists the audio frequencies for carrier nulls at several popular deviations (use 75-kHz deviation for wideband fm receivers); it is not practical to use carrier nulls beyond the third.

In most cases it’s not necessary to make an actual deviation measurement; reliable fm microwave communications can be obtained by a simple adjustment of the speech gain control for no audible distortion. Once the speech gain had been adjusted, turn on the tone oscillator and adjust the tone signal level for a signal strength approximately the same as for voice. If you have both input and output controls in your speech amplifier, set the output control for full deviation or minimum audio distortion with the microphone gain control set at about one-half full gain — this will leave plenty of leeway for microphones with higher or lower output. Set the tone oscillator level as before.

If you don’t have a friend with a Gunnplexer, you can use the Boomerang system shown in fig. 25, which was originated by the San Bernadino Microwave Society. All you need is an X-band crystal mixer and a 1 to 2 mW local-oscillator source at 30 MHz (if you’re using a 30-MHz i-f receiver). When setting up the mixer, be sure to provide a dc return (rf choke) for the mixer diode. Place the mixer 100 meters (300 feet) or so from the Gunnplexer. The transmitted signal from the Gunnplexer will mix with the 30-MHz LO, be re-radiated, and picked up by the Gunnplexer receiver. With this system you can make all the adjustments discussed previously.

When using the Boomerang system don’t place the X-band mixer too close to the Gunnplexer. If it is too close, primary 30-MHz radiation from the LO will feed directly through to the i-f receiver. You can tell very quickly if this is happening because the receiver will be completely blocked.

**radiation hazard**

Although 20 mW isn’t usually considered to be very much rf power, in the Gunnplexer it’s concentrated at the small, open end of the waveguide, so power density is about 6.2 mW per square cm (up to 19 mW/cm² for higher-powered Gunnplexers). This is considerably above OSHA’s 10 mW/cm² safety limit. Fortunately, rf power density falls off to safe levels with a few feet (2 meters), but remember that your eyes are especially susceptible to damage from rf radiation — never look into the open end of a Gunnplexer while it’s operating.

**references**

2. James R. Fisk, W1DTY, “Receiver Sensitivity, Noise Figure, and Dynamic Range — What the Numbers Mean,” ham radio, October, 1976, page 8.
A COMPLETE HOMEBREW GUNNPLEXER STATION FOR LESS THAN $210

GUNNPLEXERTM TRANSCEIVER "FRONT END"
by MICROWAVE ASSOCIATES

Amateur microwave communications is fascinating and challenging ... and now available to virtually anyone at a remarkably low cost! Applications include full duplex talking across town, controlling repeaters, sending and receiving television and data. They also include contesting, DXing and just plain talking. WHITEHOUSE offers the entire GUNNPLEXER line and all necessary support systems. Here are a few features of the Gunnplexer:

- low cost
- high sensitivity
- integrated assembly
- electronically tunable
- high reliability
- low operating voltage

Single Unit $119.95
MA 87140-1
(includes one 10 GHz, 10 mW Transceiver and Antenna)

PAIR $199.95
MA 87141-1
(includes two 10 GHz, 10 mW Transceivers and Antennas)

FREE INTRODUCTORY GUNNPLEXER BOOKLET AVAILABLE UPON REQUEST

GUNNPLEXERTM RECEIVER BOARD KIT
- just what you need to get your Gunnplexer on the air
- easy assembly with state-of-the-art ICs
- features American components
- ports for "S" and zero meters
- AFC output for support board at right
- prompt delivery

One of the Gunnplexer essentials — Order yours today!

Introductory Price
Regularly $69.95
$79.95 Model GR-1

RUSH ORDER? CALL (603) 673-7724
VISA/MASTER CHARGE ORDERS WELCOMED
Prices subject to change without notice. Please add $2.00 per order for shipping and handling.

COMPLETE GUNNPLEXERTM TRANSCEIVER PACKAGE
1 Gunnplexer
MA 87140-1 . . . . . . . $119.95
1 Receiver Board Kit
GR-1 . . . . . . . . . . . . . $69.95
1 AFC/Power Supply/Modulator Kit
GS-1 . . . . . . . . . . . . . $54.95

SAVE 15%
Regular Price $244.85
Packaged Price $209.95

(Offer valid through April 30, 1979)

G.R. WHITEHOUSE & CO.
10 Newbury Drive, Amherst, NH 03031
285
- 6dB Gain
- ½ Wave Colinear Array
- Ground Independent
- Low Angle Radiation
- Power Rated to 150 watts
- DC Grounded
- 96” overall

290
- 5 dB Gain
- ½ Wave Colinear Array
- Low Angle Radiation
- Power rated to 250 watts
- 72” overall

39.95
Amateur Net.

24.95
Amateur Net.

Available from your Hy-Gain Dealer

Our Name Says Everything
Our Name Says Everything

Hy-Bander VHF Mobile
Antennas combine broad bandwidth with high efficiency. 1/2 wave design provides low angle radiation for maximum gain. The exclusive Hy-Gain ratchet foldover will adjust through a 180° arc. The ratchet will hold its whip position even at 150 mph. Hy-Gain’s high-powered ceramic magnet grips the vehicle’s surface at speeds up to 120 mph. Hy-Gain’s use of a fiberglass printed circuit loading coil insures incredible tuning accuracy for low VSWR. PC board technology provides up to 50% more surface area for improved conductivity.

- Less than 1.4:1 VSWR 144-148 MHz
- Power Rated to 150 watts
- 1/2 Wave - 3 dB Gain
- DC Grounded
- Unique Foldover Capability
- 120 MPH Rated (Magnetic)

19.95 Magnetic
Model 287

15.95 Trunk Lip
Model 286

Available from your Hy-Gain Dealer
quieting amplifiers
for fast CW break-in

Eliminate the clank and clatter of antenna transfer relays by using this fast and quiet T/R relay

Observations made over a period of years indicate the majority of amateurs still cling to the push-to-talk method of operating their linear amplifiers during CW and voice operation. Continued use (or abuse) of push-to-talk operation can be blamed, in a large part, for the loud clacking noise generated by transfer (exciter/final) relays installed in most linear amplifiers. In an otherwise quiet ham shack, this loud and rapid clacking can become very annoying during both CW and phone operation.

The T/R relay unit described in this article, and linear amplifier modification, will go a long way in

By Nick Lefor, W1DB, 2A Knollwood Acres, Storrs, Connecticut 06268

fig. 1. Full-scale drawing of the interconnections between the T/R relay unit, amplifier, and antennas. The four phono connectors, mounted on the small Minibox, are used for the connections to the receiver and control circuits.
reducing the noise generated by the linear amplifier transfer relay; it will also provide fast CW break-in and VOX operation.

Basically, the T/R relay unit and system is a free adaptation of the ideas suggested by Dick Frey, K4XU. The T/R relay unit consists of permanently connecting the operating antenna to the linear amplifier rf output connector through a UHF T connector. As seen in fig. 1, the T/R relay unit acts as the interconnection between the exciter/amplifier, receiver, and antenna. When the amplifier is being used, the STANDBY/OPERATE switch, having been rewired, holds in the amplifier’s internal transfer relay, with the T/R unit controlling the operating bias. During exciter-only operation, placing the switch in STANDBY will bypass the rf around the amplifier.

construction

The T/R relay unit consists of a small, aluminum utility box, approximately 7.6 × 7.6 × 5.1 cm (3 × 3 × 2 inches [Radio Shack 270-235]), UHF and phono connectors, and a miniature dpdt 12 Vdc relay [Radio Shack 275-206]. The miniature relay is wired between the connectors using no. 22 (0.6mm) AWG wire. In addition, it’s supported by small urethane pads which also serve as sound absorbers.

operation

When K2 (see fig. 2A) is operated by the exciter/transceiver auxiliary T/R contacts, K2A transfers the receiver’s antenna input from the antenna to ground. K2B shorts the amplifier cutoff bias resistor (R2, fig. 2B) to ground, thereby placing the proper operating bias on the amplifier tube. The 1N914 diodes are installed for receiver input protection. The 1N4006 diode, installed across relay coil K2, is used for transient switching protection. This diode has a tendency to delay the release time of K2, however this delay is not noticeable, even at high keying speeds. The modifications, as outlined, are for a TENTEC "Triton IV" transceiver and a DenTron "MLA-1200" linear amplifier. However the principles can be applied to other linear amplifier-receiver/transceiver combinations.

results

Although the response time (T/R switching) and quieting does not approach that outlined by Dick Frey’s article, the results have been quite satisfactory — and less expensive. Fast CW break-in at the 1-kW input level has been retained, with no transients present on either transmitting or receiving. A gratifying improvement is the absence of the noise generated by the amplifier transfer relay. Note that this system of break-in can be applied only to receiver/exciter combinations and transceivers having a separate receiver antenna input.

I wish to acknowledge the helpful suggestions of Milt Hirsch, W1AUB.

references


ham radio
### OX OSCILLATOR
Crystal controlled transistor type. 3 to 20 MHz, OX-Lo, Cat. No. 035100. 20 to 60 MHz, OX-Hi, Cat. No. 035101.
Specify when ordering:
$4.95 ea.

### OF-1 OSCILLATOR
Resistor/capacitor circuit provides osc over a range of freq with the desired crystal. 2 to 22 MHz, OF-1 LO, Cat. No. 035108. 18 to 60 MHz, OF-1 Hi, Cat. No. 035109.
Specify when ordering:
$4.25 ea.

### MXX-1 TRANSISTOR RF MIXER
A single tuned circuit intended for signal conversion in the 30 to 170 MHz range. Harmonics of the OX or OF-1 oscillator are used for injection in the 60 to 179 MHz range. 3 to 20 MHz, Lo Kit, Cat. No. 035105. 20 to 170 MHz, Hi Kit, Cat. No. 035106.
Specify when ordering:
$5.50 ea.

### PAX-1 TRANSISTOR RF POWER AMP
A single tuned output amplifier designed to follow the OX or OF-1 oscillator. Outputs up to 200 mw, depending on freqency and voltage. Amplifier can be amplitude modulated 3 to 30 MHz, Cat. No. 035104.
Specify when ordering:
$5.75 ea.

### SAX-1 TRANSISTOR RF AMP
A small signal amplifier to drive the MXX-1 Mixer. Single tuned input and link output. 3 to 20 MHz, Lo Kit, Cat. No. 035112. 20 to 170 MHz, Hi Kit, Cat. No. 035103.
Specify when ordering:
$5.50 ea.

### BAX-1 BROADBAND AMP
General purpose amplifier which may be used as a tuned or untuned unit in RF and audio applications. 20 Hz to 150 MHz with 6 to 30 db gain. Cat. No. 035107.
Specify when ordering:
$5.75 ea.

### EXPERIMENTER CRYSTALS
(HC 6/U Holder)

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Specifications</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>031080</td>
<td>3 to 20 MHz — for use in OX OSC Lo</td>
<td>$5.95 ea.</td>
</tr>
<tr>
<td>031081</td>
<td>20 to 60 MHz — For use in OX OSC Hi</td>
<td>$5.95 ea.</td>
</tr>
<tr>
<td>031300</td>
<td>3 to 20 MHz — For use in OF-1L OSC</td>
<td>$4.75 ea.</td>
</tr>
<tr>
<td>031310</td>
<td>20 to 60 MHz — For use in OF-1H OSC</td>
<td>$4.75 ea.</td>
</tr>
</tbody>
</table>

Shipping and postage (inside U.S., Canada and Mexico only) will be prepaid by International. Prices quoted for U.S., Canada and Mexico orders only. Orders for shipment to other countries will be quoted on request. Address orders to:
M/S Dept., P.O. Box 32497, Oklahoma City, Oklahoma 73132

INTERNATIONAL CRYSTAL MFG CO., INC.
10 North Lee / Oklahoma City, Okla. 73102
It's Thomas Communications For Top Quality Equipment and Service

FREE
- Call Toll-Free 1-800-243-7765
- Retail Price Catalog
- Monthly Used Equipment List

OVER 50 BRANDS IN STOCK
- KENWOOD • SWAN • KDK • DENTRON
- MOSLEY • WILSON • YAESU • DRAKE
- LARSEN • BENCHER • KLM • BEARCAT
- B & W • DATONG • ICOM • PANASONIC
- ARR'L PUBLICATIONS • ALLIANCE • BIRD
- CUSHCRAFT • TRAC • MICROLOG • CDE
- HAM KEY • MEJ • DAYBURN INSULATORS
- DSI • SAXTON • TEN TEC • REGENCY
- HUSTLER • ASTATIC • PIPO • AMCOMM
- AMECO • CALL BOOK • FINCO • TEMPO

★ NEW AND USED EQUIPMENT
   "Get on our used equipment mailing list"
★ TRADES WELCOME
   "The best allowances anywhere"
   "We buy good used SSB gear"
★ FREE CATALOG
   "Prices of all major manufacturers"
★ SAME DAY U.P.S. SHIPPING
   "Just a phone call away"
★ COMPLETE RADIO SERVICE SHOP
   • Fast Efficient Service • We Repair All Brands • All Work Guaranteed • Amateur Extra/First Class Licenses • Send Us Your Defective Equipment U.P.S. Collect • Free Shipping Both Ways If Work Is Done • Most Repairs Done & Shipped Within 7 Days
★ OUR FINE REPUTATION SPEAKS FOR ITSELF ★ "YOU SHIP IT — WE FIX IT"

Call or write for your super quote today!
Connecticut Residents Call: 203-667-0811
95 Kitts Lane
Newington, Conn. 06111
"Near ARRL Headquarters"

OPEN MON.-FRI. 10-6 • THURS. 10-8 P.M. • SAT. 10-4
EASY DIRECTIONS: Rt. 15 South — 2 blocks past McDonald’s (Berlin Turnpike)
High output current, adjustable voltage, and a low parts count highlight the benefits possible with the Fairchild μA78/79 hybrid voltage regulators.

The cost of the device is competitive with that of the discrete components. The parts count is a mere eight, including power transformer, rectifier, and filter capacitor, and the numerous possible applications include solid-state power amplifiers, vhf rigs, large digital projects, repeater supplies, audio equipment, and variable bench supplies.

**Table 1. Characteristics of the Fairchild hybrid.**

| Voltage Regulators | 40 volts
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Voltage Maximum</td>
<td>40 volts</td>
</tr>
<tr>
<td>Output Current</td>
<td>5 amps</td>
</tr>
<tr>
<td>Minimum Input-Output Differential</td>
<td>3 volts</td>
</tr>
<tr>
<td>Maximum Input-Output Differential</td>
<td>25 volts</td>
</tr>
<tr>
<td>Line Regulation</td>
<td>1 per cent V_{out}</td>
</tr>
<tr>
<td>Load Regulation</td>
<td>1 per cent V_{out}</td>
</tr>
<tr>
<td>Control Pin Voltage</td>
<td>4.8-5.2 volts</td>
</tr>
<tr>
<td>Short Circuit Current Limit</td>
<td>7 amps</td>
</tr>
</tbody>
</table>

Table 1 summarizes the electrical characteristics of this device family, which also includes three fixed-output devices with otherwise identical specifications: μA78H05C (5 volts), μA78H12C (12 volts), and μA78H15C (15 volts). The fixed-output regulators come in a standard 2-pin TO-3 case and include internal voltage-set resistors.

All of these regulators have thermal overload protection against excessive dissipation or current drain, along with internal short-circuit protection to limit current output. Safe area protection is provided for.
the output transistors. When a short circuit is seen by the regulator, the rise in internal temperature puts it into thermal overload, shutting down the device for as long as the current demand generates excessive heat. The short circuit current limit is 7 amperes.

The basic positive regulator circuit (78HGC) is shown in fig. 2. R1 and R2 may be determined by the simple equations shown with the circuit. The nominal reference voltage on the control terminal is 5.0 volts (4.8 to 5.2 volts). To produce the recommended 1.0 mA current flow in the control string would require making \( R2 = 5k \) ohms. With \( R2 = 5k \) ohms, the output voltage becomes \( V_{out} = \left(\frac{R1 + R2}{R2}\right) \times \text{control voltage} \) (where R1 and R2 are in k-ohms). For example, if the supply is to provide 13.8 volts and \( R2 = 5k \) ohms, then R1 must equal 8.8k ohms. Precise setting would require trim pots.

As with virtually all such regulators, input and output capacitors should be used to improve transient response and to prevent oscillation of the regulator under certain feedback conditions. These capacitors also provide rf-field protection. Tantalum capacitors are preferred, but good quality ceramic discs may be used. Mounting should be as close to the device as possible.

The four-pin base diagrams (top view) for the regulators are shown in fig. 3. Note that the pin-outs for the two devices are different. The case is electrically isolated from the internal circuitry in the four-pin adjustable devices, but is the common in the fixed-output regulators.

Mounting may be accomplished with or without a socket. I have used a modified TO-3 socket by removing the center (collector) pin and drilling two additional holes for pins 2 and 3. Mounting R1 and R2 directly at the regulator will significantly improve the load regulation of the device.

This series of regulators is rated for 50 watts of internal power dissipation at a case temperature of 25°C. Increased case temperature, of course, reduces this rating. A graph of maximum power dissipation versus case temperature is shown in fig. 4.

To achieve rated performance, attention must be paid to both heatsinking and input voltage, which are interrelated. Under normal operation the regulator will see some input voltages greater than that demanded as its output. The minimum input-output differential should be approximately 3 volts for proper regulation. The greater the difference between the input to the regulator and its output, the greater the dissipation required by the device (actually, by its internal pass transistors). By tailoring the input voltage to the output voltage, heatsinking requirements are reduced, i.e., less heat must be dissipated in normal operation. To draw 5 amps from the regulator would set a maximum limit on the input-output differential of 10 volts. A lower differential reduces the heat to
6 GOOD REASONS FOR BUYING A HAL-TRONIX FREQUENCY COUNTER

(1) 100% COMPLETE KIT, (2) EASY ASSEMBLY, (3) COMPLETELY ENCLOSED IN METAL CABINET, (4) IC SOCKETS USED THROUGHOUT FOR EASY TTL REPLACEMENT (5) EASY ON YOUR POCKET BOOK, AND (6) NO EXPENSIVE CHIPS TO REPLACE (EXAMPLE: IF YOU LOSE A DECODER, LATCH OR DRIVER IN A HAL-TRONIX COUNTER, THE AVERAGE COST OF REPLACEMENT OF THE LOW-COST TTLS IS LESS THAN $1.00 EXCLUDING THE PRE-SCALE CHIP, IN SOME OF THE NEWER COUNTERS NOW BEING MARKETED BY MANY COMPETITORS. THIS IS SOMETHING YOU SHOULD CONSIDER.

ATTENTION RADIO CLUBS
For club or group projects, request FREE information about our DISCOUNTS on any of the HAL-TRONIX kits. Discounts range from 10-25%, depending upon the quantity needed. We are experienced in supplying kits in volume quantities to schools, laboritories, clubs, and common-interest groups. Nobody beats HAL-TRONIX quality and price. Just try us and see for yourself!

HAL-300A 7-DIGIT COUNTER WITH FREQUENCY RANGE OF ZERO TO 300 MHz. FEATURES TWO INPUTS: ONE FOR LOW FREQUENCY AND ONE FOR HIGH FREQUENCY, AUTOMATIC ZERO SUPPRESSION TIME BASE IS 1.0 SEC OR 1.0 SEC GATE W/ OPTIONAL 10 SEC GATE AVAILABLE. ACCURACY ± 0.001%. UTILIZES 10-MHz CRYSTAL 5 RPM.

PRE-SCALER KITS
HAL 500 PRE ........ $19.95
(Pre-drilled 610 board and all components)  
HAL 500 A/PRE ......  $24.95
(Pre-drilled 610 board and all components)  
HAL 600 PRE ........ $19.95
(Pre-drilled 620 board and all components)  
HAL 600 A/PRE ...... $39.95
(Same as above but with pins)  

SPECIAL — due to OVERSTOCK (while they last)!
FAIRCHILD FND-70 common cathode readouts (can replace FND-359 same pin-out)

Fig. 4. Graph of the maximum power dissipation for different case temperatures.

be dissipated. For example, a 13.8-volt supply drawing 5 amps and fed by a 24-volt input would require heatsinking sufficient to dissipate approximately 50 watts in normal use. This same supply fed by an 18-volt input must accommodate only slightly over 20 watts.

Many transformers may be easily modified to adjust their output voltage. Generally, the secondaries of these low-voltage transformers are on the outside and are readily reached after the laminations are removed. A count of the secondary turns will yield the voltage-turn ratio, making it a simple matter to remove (or, for that matter, add) the necessary turns. What you are looking for finally is an output voltage (after rectification and filtering) that, with full load, is only slightly above the 3-volt minimum input-output differential.

Heatsinking must keep the junction temperature below 125°C to meet specifications. Typically, a sink with a thermal resistance of approximately 1.5°C/watt would be adequate. Proper mounting, along with the use of a good thermal compound, is required.

This series of hybrid regulators from Fairchild offers a significant reduction in the parts count and complexity of power supplies. Its substantial current capacity, along with regulation quality and device protection, make it an economical solution to a wide variety of amateur power-supply applications. The zener diode is increasingly being moved out of the power supply business as integrated regulators become more diverse. These Fairchild regulators are one more step in that evolution.
UPGRADE TO AN EXTRA CLASS SIGNAL

ATB-34

THE COMPLETE 3 BAND ANTENNA

BY

cushcraft

IN STOCK WITH YOUR LOCAL DEALER

IN CANADA:
SCOTCOMM RADIO LTD. - 4643 Levesque Blvd. - Chomedey, Laval, Quebec

WORLDWIDE:
MAGNUS - 5715 North Lincoln Ave. - Chicago, Ill., U.S.A. 60639

P.O. BOX 4680, MANCHESTER, N. H. 03108
The age of tone control has come to Amateur Radio. What better way to utilize our ever diminishing resource of frequency spectrum? Sub-audible tone control allows several repeaters to share the same channel with minimal geographic separation. It allows protection from intermod and interference for repeaters, remote base stations, and autopatches. It even allows silent monitoring of our crowded simplex channels.

We make the most reliable and complete line of tone products available. All are totally immune to RF, use plug-in, field replaceable, frequency determining elements for low cost and the most accurate and stable frequency control possible. Our impeccable 1 day delivery is unmatched in the industry and you are protected by a full 1 year warranty when our products are returned to the factory for repair. Isn't it time for you to get into the New Age of tone control?
OF A NEW AGE.

**TS-1**  Sub-Audible Encoder-Decoder • Microminiature in size. 1.25" x 2.0" x .65" • Encodes and decodes simultaneously • $59.95 complete with K-1 element.

**TS-1JR**  Sub-Audible Encoder-Decoder • Microminiature version of the TS-1 measuring just 1.0" x 1.25" x .65", for hand-held units • $79.95 complete with K-1 element.

**ME-3**  Sub-Audible Encoder • Microminiature in size, measures .45" x 1.1" x .6" • Instant start-up • $29.95 complete with K-1 element.

**TE-8**  Eight-Tone Sub-Audible Encoder • Measures 2.6" x 2.0" x .7" • Frequency selection made by either a pull to ground or to supply • $89.95 with 8 K-1 elements.

**PE-2**  Two-Tone Sequential Encoder for paging • Two call unit • Measures 1.25" x 2.0" x .65" • $49.95 with 2 K-2 elements.

**SD-1**  Two-Tone Sequential Decoder • Frequency range is 268.5 - 2109.4 Hz • Measures 1.2" x 1.67" x .65" • Momentary output for horn relay, latched output for call light and receiver muting built-in • $59.95 with 2 K-2 elements.

**TE-12**  Twelve-Tone Sub-Audible or Burst-Tone Encoder • Frequency range is 67.0 - 263.0 Hz sub-audible or 1650 - 4200 Hz burst-tone • Measures 4.25" x 2.5" x 1.5" • $79.95 with 12 K-1 elements.

**ST-1**  Burst-Tone Encoder • Measures .95" x .5" x .5" plus K-1 measurements • Frequency range is 1650 - 4200 Hz • $29.95 with K-1 element.

**COMMUNICATIONS SPECIALISTS**
426 West Taft Avenue, Orange, CA 92667
(800) 854-0547, California residents use: (714) 998-3021
digital readout
for the
Ham-3 rotator

Add a digital readout to the Ham-M rotator series by incorporating this simple but accurate analog-to-digital converter.

It appears that Amateur Radio has gone digital. The signs of change are all around the shack. First came the digital IC keyer, which later had a digital memory added. Digital frequency readout was once a luxury; now, it's a standard feature of most new transceivers. Every shack, of course, now sports a digital clock built from a $3 clock IC. With the exception of the keyer, all the "digital" applications are merely conversions of analog data to digital readout. Since this trend is likely to continue, it's worth looking into.

Electronic analog-to-digital conversion can be accomplished using several different techniques.* These include parallel (or "flash") tracking, successive approximation, or single- and dual-ramp converters. The flash converter is often used in extremely high-speed applications. Successive approximation is a general-purpose, medium-speed approach, while the dual-ramp or dual-slope is suited to low-speed applications. Integrated circuits are now available at reasonable cost to perform each of these conversions. In choosing a converter, you must consider several aspects: speed, accuracy, resolution, and output format. The actual analog signal being converted must also be considered. Is it a voltage or a current? Perhaps the best way to illustrate the reasoning behind a data-conversion project is by example.

The largest analog indicator in my shack is the meter on my HAM-3 control box, an obvious choice for digital readout. First, consider the A-D converter. Speed is not essential. Conversion times of a few hundred milliseconds are acceptable, so a dual-slope converter is adequate. The accuracy of this system is likely to be limited by the linearity of the Ham-3 indicator system, since most converter products are within 0.1 per cent accuracy. The Ham-3 indicator has an accuracy of about 5 degrees. Resolution is a term describing the number of discrete values that can be recognized, in the same way that digital frequency readouts have resolution limitations. It seems foolish to have rotator readouts to tenths of a degree. A resolution of 1 part in 360 is adequate.

Since converter manufacturers produce both binary- and BCD-output devices, output format must be chosen. In this application, since the readout is a seven-segment visual display, the BCD output is the

*For detailed discussions of conversion techniques an excellent text, Analog-Digital Conversion Notes, is available from Analog Devices Incorporated, Norwood, Massachusetts, for $5.95.

By Doug Grant, K1DG, 20 Oak Street, Winchester, Massachusetts 01890
best choice. If you wanted to control the station from the shack computer (no doubt many hams are already considering this), a binary output would be better since computers tend to think in straight binary.

The Analog Devices AD2020, a 3-digit BCD output A-D converter, fits the requirements. It is a low-cost, low-speed, 3-digit BCD output converter widely used in digital panel-meter applications. It is an excellent choice for the HAM-3 digital display because it requires a minimum of external components; the readout is in millivolts. If a 0-359 millivolt signal representing the antenna heading is generated, the IC receives a convenient scale requiring no special conditioning.

**signal conditioning**

First, consider the original indicator circuit. Referring to fig. 1, the 13-volt zener reference is applied directly across the 500-ohm slide wire potentiometer inside the rotator. The wiper of the pot is connected through a 10k-ohm fixed resistor, the 5k-ohm calibration pot, and the meter to the plus side of the 13 volts. The current flowing through the meter is 1 mA at full scale, representing full clockwise rotation. When the rotator is moved to the full counterclockwise position, no current flows. Unfortunately, CDE chose to return the wiper of the indicator pot through the “ground” line, which also carries the ac for the brake and motor circuits. This causes problems with the digital display that aren’t apparent when only the original analog meter is used. More on this later.

If you consider the voltage at the wiper of the pot with respect to the minus side of the regulated 13-volt supply, it varies linearly from 0 volts at full clockwise to 13 volts at full counterclockwise. A resistive voltage divider must be used to reduce this to a usable 0-360 millivolt range. In addition, this divider must have a high enough input impedance that it doesn’t load down the pot. At mid scale, the pot represents a source impedance of 250 ohms, decreasing to zero at either extreme of its travel. The resistive divider shown in fig. 2, 100k-ohms and 2.49k-ohms, will not cause loading problems. In addition, the 100 meg-ohm input impedance of the AD2020 will not cause errors due to loading effects on the equivalent source impedance of the voltage divider.

**circuit description**

Now that the required signal conditioning has been accomplished, support for the AD2020 chip must be examined. Very little additional circuitry is required. The displays can be any common-anode LEDs. Liquid crystals can be used, at the added expense of some additional circuitry. Personally, I like the LEDs, since they are more visible under the cowl of the control-box cover. Driver transistors for the LEDs can be any pnp transistor capable of delivering about 100 mA. The AD2020 is designed to mate with the Fairchild 9374 decoder/driver chip. This chip differs from the commonly used 7447 in that it has on-board current limiting and requires no resistors. Also, the displays for numbers greater than BCD 9 are different. When used as a pair, the decoding provides EEE for positive overload and --- for negative overload. If a 7447 is used, the – sign decodes as a C. The blanking inputs use different logic on each of these chips, so use caution is you substitute. Current-limiting resistors of 330 ohms should also be used with the 7447. The integrating capacitor is shown on the AD2020 data sheet at 0.27 μF. I used 0.1 μF with good success, so this value doesn’t appear too critical.

Power for the readout circuit is derived from avail-
able voltages in the control box (see fig. 3). Since the services of the indicator lamp are no longer required, it can be removed. Once the lamp is removed, the instrument transformer in the control box is capable of furnishing the approximately 150 mA required by the digital readout circuit. A separate regulator, such as the LM309 or a 7805-type, is used.

**calibration and antenna positions**

In order to keep the circuit simple, the readout is based on a south-centered scale. This way, one rotation extreme represents 0 degrees and the other represents 360 degrees. In a north-centered system, full clockwise represents 180 degrees, midscale is

This regulator is supplied from the half-wave rectified and filtered dc from the transformer, tapped off points 11 and 13 on the power supply board of the Ham-3. Point 13 is treated as the "ground" for this supply. A heat sink must be used on the regulator, or separate regulators should be used for display power and for power to the AD2020 chip.

Construction of the circuit is not terribly critical. I built the prototype on perforated board cut to fit behind the original meter bezel. A scrap of rubylith was used as a red filter to conceal the other components on the board and to yield a nice-looking front panel.

360 degrees or 0 degrees, and full counterclockwise represents 180 degrees again. This presents a more complex problem. A 180-millivolt offset must now be switched in and out, requiring a comparator, relay, and reference supply. In my opinion, the headaches of trimming such a circuit outweigh the hassle of climbing the tower to turn the beam 180 degrees inside the rotator. In addition, changing the stop to north from south has another hidden advantage. In general, propagation follows a clockwise route. This means that conditions tend to favor Europe, then Africa, swinging south through the Americas, on into the Pacific, and finally to Japan. In the original

![fig. 2. Diagram of the digital readout system. The 5-volt common line is not chassis grounded; it is tied to the bottom of the zener reference. C2, across the input of the A-D converter, is used to prevent the ac voltage developed across the cable resistance from producing an erroneous readout.](image)
configuration, having the stop at south made you swing your beam almost a complete revolution in order to follow the propagation as the peak passes due south.

When you change antenna position, first turn the rotator full counterclockwise. Then turn the antenna north with enough feedline slack to allow a full clockwise rotation. Finally, reverse the connections to terminals 3 and 7 on the back of the control box. This is done to provide a full-scale voltage at full clockwise rotation. As originally configured by CDE, full clockwise provides full-scale current and zero voltage at the wiper of the pot relative to pin 7.

Calibration of the circuit is fairly simple. The original CALIBRATE button on the control box now serves no function. First apply power to the unit with the rotor in the full counterclockwise position. After a few minutes' warmup, adjust the zero pot, R5, for a reading of 000. Now rotate the antenna full clockwise. Then adjust the voltage divider trimpot, R2, for a reading of 360. The readout is now fully calibrated.

When I first installed the readout in my Ham-3, the display was rock stable until the brake release switch was pressed. As fig. 4 shows, a large amount of brake and motor ac current flows through the common ground connection, causing the display to jump wildly. The problem was solved by placing C2, a 100-μF electrolytic capacitor, across the inputs to the AD2020. This capacitance represents a low impedance to 60 Hz ac and reduces the effects of the ground currents to less than 1 count. In some cases, rf bypassing might also be required. A .001-μF ceramic capacitor should provide adequate rf filtering.

summary

Before long, dozens of other analog functions around the ham shack will be converted to digital, either for readout or for computer control. The same considerations discussed in this article will arise in any situation requiring analog-to-digital conversion. As converter ICs become increasingly available to the amateur, an understanding of the underlying principles will become important.

Consider the following scenario. The station digital clock indicates 0000 UTC, signaling the station computer that the contest has begun. The receiver tuning algorithm is initiated, applying voltage through a digital-to-analog converter to a varactor in the receiver vfo. A signal is found, and the program jumps to the identification routine, including the Morse code translator. The station is identified and found to be calling CQ TEST. A quick check through memory shows that the station is not a duplicate. Elsewhere in memory, the correct beam heading is found. The rotator position is read in from its analog-to-digital converter, and the computer determines in which direction to begin turning the antenna. At the correct heading, signal strength is read from another A-to-D, and the RST for the exchange is computed. The keyer speed is adjusted and the computer now calls the other station. When the QSO is completed, the computer logs the contact and the sequence repeats. With an advanced system like this, a contest operator can relax and watch the football game on TV while his station operates itself and prepares a printed, duplicated log within minutes of the end of the contest.

references

TS-520S and DG-5
DIGITAL FREQUENCY DISPLAY

It's an ideal choice for anyone looking towards owning a highly reliable, highly efficient amateur radio transceiver. Full coverage, 160 through 10 meters...digital readout with optional DG-5...effective noise blanker and audio processor...RF input power: 200 watts PEP on SSB, 160 watts DC on CW. The TS-520S transceiver provides full transmit and receive coverage of all Amateur bands from 160 through 10 meters. It also receives 15.0 (WWV) to 15.5 MHz and another 500-kHz range of your choice in the auxiliary band position. With the optional DG-5, you have a large digital frequency readout when transmitting and receiving, and the DG-5 also doubles as a 40-MHz frequency counter. The TS-520S includes a built-in AC power supply, and, with the addition of the optional DS-IA DC-DC converter, it can function as a mobile rig. It features a very effective noise blanker, RIT, eight-pole crystal filter, 25-kHz calibrator, front-panel carrier level control, semi-break-in CW with side-tone, built-in speaker, heater switch, 20-dB RF attenuator and easy phone-patch connection. RF input power is 200 W PEP on SSB and 160 W DC on CW. Carrier suppression is better than 

-40 dB and sideband suppression is better than 

-50 dB. Spurious radiation is less than 

-40 dB. Receiver sensitivity is 0.25 μV for 10 dB (S+N)/N. Selectivity is 2.4 kHz at 

-6 dB/4.4 kHz at 

-60 dB and, with the optional CW-520 CW filter, is 0.5 kHz at 

-6 dB/1.5 kHz at 

-60 dB. See your Authorized Kenwood Dealer now for complete information!
Covers the range.

Kenwood's TS-700SP... a time proven rig that now covers the new repeater subband (144.5 to 145.5 MHz).

TS-700SP features all of the fine attributes of the TS-700S: A digital frequency display, receiver preamp, VOX, semi-break-in, and CW sidetone. Of course, it's all mode, 144-148 MHz, VFO controlled... and Kenwood quality throughout.

FEATURES:
- 4 MHz band coverage (144 to 148 MHz).
- Automatic repeater offset capability on all FCC authorized repeater subbands, including 144.5-145.5 MHz.
- Simply dial receive frequency and radio does the rest... simplex, repeater, or reverse. Same features on any of 11 crystal positions.
- Transmit/receive capability on 44 channels with 11 crystals.
- Operates all modes: SSB (upper and lower), FM, AM and CW.
- 3 watts on AM.
- Digital readout with “Kenwood Blue” digits.
- Receiver preamp.
- Built-in VOX.
- Semi-break-in on CW.
- CW sidetone.
- All solid-state.
- AC and DC capability.
- 10 watts RF output on SSB, FM, CW.
- 1 watt FM low-power switch.
- 0.25 μV for 10 dB (S + N)/N SSB/CW sensitivity.
- 0.4 μV for 20 dB quieting FM sensitivity.

Get all the details and see the TS-700SP now at your nearest Authorized Kenwood Dealer!
anodizing aluminum
in the amateur workshop
Complex chemical processes for treating aluminum are translated into simple procedures for your home lab.

Aluminum is used in many construction projects. But how do you decide on which type of aluminum to use? If you’re interested in making panels, chassis, or boxes to house equipment, there’s a right way to process the metal for durability and appearance. This article gives some pointers on how to process aluminum by anodizing, a chemical process that can be used in your workshop. Also included is information on how to apply colored dye to aluminum parts using simple procedures.

Aluminum is one of the most abundant elements on earth, forming about 8 per cent of the earth’s crust. It’s relatively inexpensive, easily machined and worked, lightweight yet strong, and an excellent electrical conductor. Its disadvantage, when uncontrolled, is its pronounced affinity for oxygen: a process called corrosion.

Aluminum oxidizes rapidly. Its natural surface breaks down, causing it to be unsuitable for applications where a long-term stable surface is needed. In ordinary atmospheric environments, even when few pollutants are present, alloyed aluminum surfaces oxidize within moments. The oxide is invisible to the naked eye; even the apparently bare surface of a recently machined aluminum part is immediately coated upon contact with atmospheric oxygen.

controlling oxidation
The formation of surface aluminum oxide can be controlled by anodizing. An electrochemical process is used to form the crystalline structure known as gamma aluminum oxide ($\gamma\text{Al}_2\text{O}_3$) in an electrolytic cell, with the item to be anodized becoming the anode in the cell. The nature of the anodized metal has particularly significant physical characteristics:

1. Extreme hardness, approaching that of diamond
2. Electrical nonconductivity
3. Extreme porosity on a molecular scale

The gamma aluminum oxide film is closely related structurally to other oxides of aluminum, such as those used in manufacturing synthetic grinding wheels, and commonly substituted for natural corundum. Synthetic sapphires and rubies are, in fact, oxides of aluminum. Even though several different compounds are designated aluminum oxide ($\text{Al}_2\text{O}_3$), the crystal lattice structure takes on many quite

By David W. Hembling, VE7DKR, 3476 Overlander Drive, Kamloops, B.C., Canada, V2B 6X5

January 1979
peculiar variations, hence the designation of the anodic film as the *gamma* aluminum oxide.

Aluminum oxide coatings, or films, vary greatly from transparent to opaque, depending on film thickness and also on the alloying elements present in the aluminum alloy used. The film thickness is controllable, and can be from one to twenty microns.* The fact that the film thus generated is molecularly bonded to the aluminum and has a porosity that can be dyed makes an anodized film the most durable and useful of all possible finishes for this metal.

The porous surface of the gamma oxide film, whether dyed or left clear, is easily converted by immersion in boiling water to the closed, or sealed, crystalline state of the monohydrate of aluminum oxide, known as boehmite, designated $\text{Al}_2\text{O}_3\cdot\text{H}_2\text{O}$ (or more correctly $\text{A}_1\text{O}_2\text{H}$). Boehmite has a large volume/area ratio of aluminum; therefore, the volume of anodized film is increased to close the pores, or seal the film. The conversion of the simpler gamma aluminum oxide to the boehmite structure makes the anodized surface unstainable, the dye unbleachable, and the item so treated remains permanently dyed in the chosen color.

**the anodizing process**

Aluminum is anodized by immersing it in an aqueous electrolytic solution in which the aluminum item to be anodized becomes the anode (positive pole). A direct current is passed to it from the cathode (negative pole). Oxygen released from the water combines with surface aluminum molecules to form aluminum oxide; the crystalline lattice is of the gamma form. Although the acid electrolyte is not used in the oxide-forming reaction, it influences the characteristics of the formed film.

Two common methods of electrolytically producing an anodic film on aluminum offer different properties in the formed anodic film. The two methods use different acids in the electrolyte, chromic or sulfuric. These methods are discussed at length below.

**alodizing**

An alternative method of protecting aluminum is called alodizing. This method provides no color choice and results in only about a 3-micron ($3 \times 10^{-3}$ mm or $1.2 \times 10^{-4}$ inch) film thickness. This process is a chemical-dip treatment, which produces an electrically conductive coating, usually of a smutty, mustard-like color. After buffing, alodizing does offer a degree of protection to the otherwise easily corrodbale metal. An unbuffed alodized finish accepts primer and finish painting.

**anodizing by the chromic-acid process**

The chromic-acid process is not suitable for aluminum alloys that contain more than 5 per cent copper, but it is fine for all other aluminum alloys. The chromic-acid process is especially recommended for anodizing assembly parts, particularly where inadequate flushing and rinsing of trapped sulphuric acid could lead to later problems. The films generated by the chromic-acid process are thinner than those obtained with the sulphuric-acid process, but despite their relative thinness, they are durable and offer a highly stable protective coating — from a corrosion standpoint especially.

The thinness of chromic-acid coatings is sometimes of value in manufacturing procedures, especially where ultra-close fits are involved and where matching is to be within sub-mill tolerances. The U.S. government specification MIL-A-8625A (December 14, 1954), which calls for 250-hour salt-spray resistance, authorizes the chromic-acid process for all aluminum alloys except those bearing more than 5 per cent copper. Although the chromic-acid-generated anodized finish is much harder than the untreated metal itself, only limited abrasion resistance is afforded by this process because of the extreme thinness of the film. Also, with the sulphuric-acid anodizing process, a greater porosity occurs, with increased dye take-up in the thicker coating.

For the purposes of the average amateur requiring the anodized film characteristics of hardness, durability, and acceptance of dyes, the sulphuric-acid process is preferable.

Three practical references,1-3 supply details on the chromic-acid process for those rare applications where an amateur may need it.

**aluminum alloys for effective anodizing**

As mentioned, the qualities of the anodic film produced are affected significantly by the presence of other metals alloyed with the aluminum. Depending on the intended use of the aluminum, cost and availability may dictate which aluminum alloy is used, rather than the precise and sometimes subtle differences between the various alloys. The chemical differences between the various aluminum alloys can
usually be found in the handbooks of large industrial suppliers of nonferrous metals.

In its purest form, aluminum is very soft and quite ductile. For most purposes, however, greater strength and hardness are required; thus high-purity aluminum is seldom used. Greater strength is achieved in two ways. Usually, the pure metal is alloyed with other metal elements, such as manganese, copper, silicon, iron, and magnesium. In addition, the alloy may be heat treated to give it even greater strength. The designation T plus a number after the 4-digit alloy number indicates a heat-treated alloy.

Aluminum of high purity, when anodized by the sulphuric-acid process, yields a completely colorless anodic film. This film can be left clear and sealed off, or dyed and then sealed off. The paler colors are more readily dyed into the anodic films generated on the surface of pure, nonalloyed aluminum. The more alloying impurities present, the greater the tendency toward a pale-green or pale-brown cast to the undyed anodic film. This is seldom a problem, unless matching of the various parts of a structure made from different alloys is desired.

When pale dyes are to be used, the original alloy must be considered, and the acid concentration as well as current density should be controlled for a thick film formation; e.g., 15-20 microns or about 1.5 x 10^-2 mm (6 x 10^-4 inch), thus permitting greater dye take-up. The more concentrated the acid electrolyte solution, the softer and more porous the anodic film.

Experimentation is often required to achieve the required anodic film properties of a particular dye. A sample scrap piece of the alloy to be used can be processed in a trial run, thereby assuring more predictable results.

Of course, more predictable results can be obtained when alloys of known composition are used. Some alloys are better candidates for taking an anodic finish than others. For example, the well-known Alcan 6061 T4 and 6061 T6 take an excellent anodic finish. The finish will reflect absolutely and exactly the smoothness or roughness of the final machining operation.

Anodizing makes no noticeable difference to the texture of the aluminum. To see the finish (except for the color), even the strongest optical microscopes are useless. As discussed earlier, the scale being dealt with here is molecular; the transmission electron microscope is required to reveal the anodic film texture. Even with a scanning electron microscope (SEM) the porosity is invisible.

the sulphuric-acid process

First of all, aluminum anodizing should not be done indoors unless special ventilating equipment can be installed. Ideally, the anodizing workshop should be outdoors with plenty of air circulation; the ideal outdoor workshop is a home carport or garage with all doors open. If something approaching a chemistry laboratory fume hood with a spark-free extractor fan can be placed over the anodizing tank to exhaust the gaseous hydrogen emitted at the cathode, indoor anodizing may be possible. Remember that electrolytic dissociation breaks water down into two atoms of hydrogen for each atom of oxygen. Oxygen reacting at the aluminum-anode surface — allowing aluminum-oxide formation — causes the liberation of hydrogen gas at the cathode. This gas is emitted with a small amount of acid vapor from the electrolyte and is best vented outdoors, where it will be rendered harmless by mixing with air.

safety precautions

Small anodizing jobs in the home workshop can be
Some people have called the Atlas RX-110 a stroke of genius. But it didn’t take much genius to design it, just a lot of common sense. Newcomers to amateur radio like to begin by monitoring amateur activity so they want an inexpensive receiver. Many old-timers like to have an extra receiver for their living room or bedroom so they don’t have to stay in the shack or car waiting for band openings. But with the recent popularity of the transceiver concept, the economical receiver simply disappeared. Now Atlas reintroduces a low price receiver: The RX-110 for $229.

**Transmit module $159.**

This is where our new concept makes even more sense (and saves you thousands of “cents”). Since many stages in a receiver are also required in a transmitter (VFO, IF Systems, Crystal Filter, Carrier Oscillator, Band-Pass Filters, and Diode Ring Mixer), we provided a connection on the back of the RX-110 so the TX-110 Transmitter Module can utilize these common stages, eliminating the cost and labor of duplicating these steps. But there is absolutely no compromise on performance with this new concept.

Simply connect the TX-110 Transmit Module to the RX-110 Receiver and you have a complete 5 band CW-SSB transceiver!

---

### Complete 5 band CW-SSB transceiver

- Provides CW and SSB communications on 10, 15, 20, 40, and 80 meters with a choice of two power levels.
- The TX-110-L runs 15 watts input on 20, 40, and 80 meters; 10 watts input on 10 and 15 meters.
- The TX-110-H runs 200 watts input on 20, 40, and 80 meters; 150 watts on 15 and 100 watts on 10 meters.
- Semi-break-in CW with sidetone monitoring is a standard feature.
- PTT (Press-to-Talk) operation on SSB. Lower sideband on 40 and 80 meters. Upper sideband on 10, 15, and 20 meters.
- TX-110-L 15 watt module runs on AC supply in RX-110, so it is completely self-contained, including speaker. Simply connect antenna, and key or mike.
- TX-110-H requires additional AC supply to supply high current for 200 watt amplifier (Model PS-110).
- 200 watt amplifier may be added to TX-110-L at a later date, thus converting it to a TX-110-H.
- The RX-110, TX-110-L, and TX-110-H will all run directly from a 12 to 14 volt DC battery supply for mobile or portable operation. When the two units are mechanically joined (brackets supplied with TX-110), the transceiver slides into a plug-in mobile mount. Model MM-110.

---

**SUGGESTED RESALE PRICES:**

- RX-110 $229.
- TX-110-L $159.
- TX-110-H $249.
- PS-110 $89.

---

**417 Via Del Monte • Oceanside, CA 92054 • (714) 433-1983 • Special Customer Service Direct Line (714) 433-9591**
done safely. The degree of hazard is similar to that of quick-charging an automobile lead-acid storage battery. The acid concentrations are roughly the same and the amount of discharged gaseous hydrogen is similar.

The major hazards are the effects of acid on skin or eye tissue and the risk of a spark's igniting hydrogen gas. Both hazards are avoidable. The golden rule of mixing acid is *always pour concentrated acid into the water — and slowly!* This allows the heat of the chemical reaction between the water and acid to be absorbed by the larger volume of water. If a sudden expansion of the smaller amount of acid should occur due to the rapid temperature increase that occurs on contact, it is water that is present in quantity, rather than the more dangerous acid. Once the 15-25 per cent solution of sulphuric acid is mixed, it then becomes the working electrolyte, in which the anodizing process takes place. After evaporation has occurred the tank can be topped-up safely by carefully pouring more water into the dilute solution.

When mixing acid, immersing an item to be anodized, or removing it, wear protective clothing such as an apron made from a heavy fabric (canvas or rubber).

Use large rubber gloves to protect the hands and wrists, and acid-proof safety goggles over the eyes. Even a tiny splash of only a few milliliters of acid can cause serious damage to the eyes. If appropriate precautions are taken and the working area is clear and safe, the degree of risk is minimized. As with other procedures, human error, misjudgement, and carelessness (including too much speed) are most dangerous. Keep a pail of water handy!

the anodizing tank

The anodizing tank must be large enough to accommodate the lead cathode (which takes up very little space) and the largest item to be anodized. (If nothing larger than a thimble is to be anodized, the tank could be a plastic coffee cup, and the process could be done indoors with minimal ventilation.) Most of the items anodized in my setup were small — seldom larger than a dinner plate. The tank can be any container that’s nonconducting and impervious to dilute sulphuric acid. A plastic pail, a hard rubber vessel, a glass tank (such as may be salvaged from a large lead-acid storage cell) or even a heavy plastic kitchen dish pan can be used.

The cathode must be constructed of lead. If the tank is a polyethylene or hard-rubber pail, round or square, the cathode can be easily fitted from a sheet of plumber's lead. Cut a 1-3 mm (0.04-0.1 in.) sheet of lead so it can be rolled into a liner in the shape of an open-ended cylinder that can be placed inside the walls of the pail. A cathode termination can be made from a 20-30 mm (0.8-1 in.) wide strip of the same lead sheet, soldered to the upper edge of the cylindrical cathode, and extended up to the top of the tank. At that point, clear of acid contact, the lead can be soldered to a flexible length of 3.3 or 2.6 mm (no. 8 or 10) copper wire for connection to the negative terminal of the anodizing power supply. The size of the cathode, in surface area, must be at least equal to the area of the surface being anodized. The cathode in my tank covers the interior walls of the pail (20 liters, or 5-1/2 gallons) and extends the full depth of the acid contained in it when about two-thirds full. The bottom of the pail remains uncovered by the cathode so that some items being anodized may be set on the nonconducting tank bottom. The tank bottom could also be covered with lead, offering a larger surface-area cathode, but it would then be difficult to avoid contact with the bottom.

The electrolytic-tank anode pole is formed by using only aluminum, including aluminum screws, bolts, or other connectors, except for parts which no acid will contact. The item to be anodized can be fastened either by friction fit or by aluminum

Scanning electron micrograph photo (×16,000). Although porosity isn't visible, the crystalline texture of the gamma aluminum oxide can be seen. The surface appears lustrous and smooth and is highly reflective. (Photo courtesy Dept. of Metallurgical Engineering, University of British Columbia, Vancouver, B.C.)
Dollar thoughts to consider about the

DRAKE UV-3

UHF-VHF MULTIBAND FM SYSTEM

Only $795 for 3-Band UV-3

(That's just $265 per band — and fully synthesized on all three!)

How does the cost of the Drake system really compare to alternative methods of getting on 144-220-440 MHz fm?

A First of all, there is no direct comparison possible, because the Model 1346 Drake UV-3 is the only rig in the world offering 144-220-440 MHz fm in a single box — and it is fully synthesized on each band.

B The nearest comparison would be to add the suggested list prices of three separate units of competitive fm rigs presently available. It would work out approximately as follows (and you would end up with three separate units to power):

- 2 Meters (Synthesized to 5 kHz) . . . . $449.00
- 220 MHz (Synthesized to 5 kHz) . . . . 449.95
- 440 MHz (23 channels, crystal) . . . . 349.00
- Crystals (Assuming 20 per 440 MHz radio) . . . . 120.00

Total competitive price . . . . $1367.95

But wait—even at those higher competitive prices you'd still be missing these features included in the UV-3:

1. Full synthesis on all three bands
2. Extra diode-programmable fixed channels on each band
3. Priority scan feature on each band
4. Everything in a single box!

For your homework, then, ponder the following—at a suggested amateur net of $795.00, the Model 1346 Drake UV-3 (144-220-440) is, to say the least, an incredible value. It gives you a real reason to trade UP!

NOW AVAILABLE: Complete UV-3 Service/Schematic Book . . $25.00 each.

R. L. DRAKE COMPANY

540 Richard St., Miamisburg, Ohio 45342
Phone: (513) 866-2421 • Telex: 288-017

Prices and specifications subject to change without notice or obligation.
fasteners to an aluminum rod or strip and hung into the central area of the tank. A wooden slat or two across the tank top serves as a stabilizer for the central anode fixtures. Connection by aluminum fasteners to the item to be anodized should be made on some part of the item where it won’t matter. The point of contact — where the anode connection is made — obscures a small area that remains unanodized.

**acid concentration**

The sulphuric-acid electrolyte used for anodizing should be between 15 and 25 per cent concentration by weight. The table below shows appropriate quantities of concentrated sulphuric acid for dilutions between 15 and 25 per cent by weight.

<table>
<thead>
<tr>
<th>acid dilution (per cent)</th>
<th>concentration per liter (quart) of water</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>173 ml (5.9 oz)</td>
</tr>
<tr>
<td>18</td>
<td>212 ml (7.2 oz)</td>
</tr>
<tr>
<td>20</td>
<td>240 ml (8.2 oz)</td>
</tr>
<tr>
<td>25</td>
<td>310 ml (10.5 oz)</td>
</tr>
</tbody>
</table>

The plastic containers of sulphuric acid sold by automotive parts stores for filling new automobile storage batteries make an excellent source of acid for anodizing. Simply mixing the acid with water in a 1:1 ratio makes a good dilution for a working anodizing solution.

Minor impurities that occur in drinking water, mainly small concentrations of minerals and alkali, will have little effect on the anodizing results. The other metals in the aluminum alloy appear to play a more important role in determining the undyed color of the anodic film. If the water is especially alkaline, the resultant acid concentration obtained by the table may give lower actual concentrations due to neutralization.

**power supply**

The power-supply capacity that will be needed is determined by the size of the aluminum items to be anodized. The current density required in the sulphuric-acid process averages 1.5 amperes per decimeter² (3.4 inch²) of surface area of the item to be anodized. However, the current density will vary in relation to several factors:

1. Acid concentration
2. Voltage potential between anode and cathode
3. Electrolyte temperature

The voltage potential is not critical, although the softer and more porous films are generated at the higher voltages and current densities. Any voltage between 6 and 20 volts will generate an anodic film, but 16-18 volts appears to be optimum when working with electrolyte temperatures between 18 and 22 C (66 - 72 F). The power supply must be able to produce full-wave direct current, not necessarily filtered, of 18 volts and 30-50 amperes for periods of about an hour without overheating.

Ordinarily the voltage is preset. Current flow will then be determined by acid concentration, temperature, and the surface area of the item to be anodized. A voltmeter and ammeter are helpful. Current flow does not decrease with anodic film buildup as in the chromic acid process.

**operating conditions**

Anodizing can be done with the electrolyte at a number of different temperatures.

When the electrolyte is started at room temperature (= 20 C, or 68 F), after several hours of anodizing a rise in electrolyte temperature can occur. This increase varies with the size of the items being anodized and the current flow through the electrolyte. As the temperature rises, the anodic film will be softer and more porous — which makes for better dye takeup — but the film will have a reduced hardness. The tank can be left to cool at this point. Sometimes the rise in electrolyte temperature is acceptable, especially when extreme hardness is not necessary and when the dark-colored dyes, such as black or deep blue, are being used.

If accelerated electrolyte cooling is required (seldom necessary in most amateur setups), the cathode could be constructed of lead tubing, with a suitable coolant pumped through it, thus permitting the electrolyte temperature to be thermostatically controlled.

Anodic-film porosity is controlled by acid concentration, current flow, and voltage, all of which are interrelated. Film thickness, however, is controlled by the length of time of film generation. Some experimentation will demonstrate more exact times and there is some latitude in this variable; but generally two categories of time length apply: if the anodic film is not to be dyed, about 15-25 minutes is usually ample. If the film is to be dyed, however, and especially with the dyes requiring a high degree of film takeup, periods in the range of 45-60 minutes should be used. Different alloys will require different times, even when all other variables are held constant, including voltage, current density, electrolyte temperature, and electrolyte concentration.

**sealing**

The anodic film generated in the electrolyte is gamma aluminum oxide. The molecular porosity of this oxide and its extreme hardness are desired characteristics. If the surface is not to be dyed, however, it will offer greater permanence to its uniform colora-
tion if it is converted to the nonporous boehmite. This conversion is easily made by immersing the rinsed and clean anodized item in boiling water for about 20 minutes.

If the anodic film has been dyed, the sealing process of simple immersion in boiling water can cause dye leaching. To avoid this, chemicals are added to the sealing solution, usually a low concentration of nickel acetate in water held at 95 - 98 C (203 - 208 F). The sealant chemical may vary depending on the dye. I've never required an antileaching agent, since a small amount of leaching has been tolerable.

**dyeing**

Commercial procedures for the uniform dyeing of anodized aluminum can be complex and expensive. One of the most critical factors is the pH of the dye solutions and sealant solutions.

The purpose of anodizing an aluminum surface, aside from increased durability and hardness, is to produce a porosity that will allow dye to penetrate. As mentioned, however, the porosity formed from the anodizing process is on a molecular scale. Unlike dyes used for cloth, where absorption of dye is an easy matter because of the large pores in the fabric, dyes capable of takeup by an anodized surface must have molecular constituents small enough to fit into the pores in the film surface. Many ordinary dyes that permanently stain ordinary fabrics have no effect whatsoever on the more subtle porosity of anodic films. For this reason, special dyes have been developed.

In North America, two large suppliers of commercial dyes and supplies for the anodizing industry are Sandoz* and the Allied Chemical and Dye Corporation.† Chemical dyes available from them come in about 50 different colors. If a more limited selection of dyes can be accepted, some ordinary, inexpensive fabric dyes sold in drugstores will prove satisfactory for anodic film takeup if a few special measures are taken. Wool dyes must be selected, rather than those only for cotton or other fibers. The pH must be controlled and the concentration must be higher. Usually about 25 grams/liter (0.9 oz./qt.) of the solute, with the addition of about 1 ml/liter (0.03 oz./qt.) of acetic acid (vaccine), will yield reasonable coloring results. Certain dyes, because of their large molecular size, will be unusable. However, after experimentation, you may find that many different dye colors can be used at a fraction of the price of commercial anodizing dyes. The golds and blues tend to be most effective, some without the addition of acetic acid.

For the most effective dye takeup by a well-generated anodic film, heating the dye solution to 55 - 75 C (130 - 167 F) is required. The dye takeup won't increase after about 10-15 minutes immersion in the heated dye. Different dyes take up at different temperatures; experiment to find the optimum values.

Very dark black anodic dye will probably have to be purchased from one of the commercial dye sources or from an anodizing shop. Commercial anodizing dyes are extremely powerful, so only a small amount will be required.

After repeated use the dye will become gradually acidic from acid leaching out of the anodized surfaces, even though these surfaces have been carefully rinsed. At this stage the pH of the dye solution must be restored by adding small amounts of alkali, usually lye solution. If the inexpensive drugstore fabric dyes are used, an alternative to fussy pH control is to replace the acidic dye with a fresh mix of new dye, a practice that has been acceptable in my experience.

**summary**

Anodizing aluminum is an exact science. For the amateur in the home workshop it may be an art that requires much experimentation before you develop consistent results. But anodizing offers many advantages over other protective coatings and yields a permanent and stable finish for aluminum.

**references**

1. George E. Best, "Chromic Acid Anodizing of Aluminum," Mutual Chemical Division, Allied Chemical and Dye Corporation, Baltimore, Maryland.

**bibliography**


"The Coloring of Anodized Aluminum," Pamphlet 4-245/73, Sandoz Colors and Chemicals Company.


† Allied Chemical and Dye Corporation, Industrial Division, 1348 Block Street, Baltimore, Maryland 21231.
Build this simple, low-cost CMOS keyer for inclusion in any battery-powered equipment.

The construction of this keyer is a result of an effort to reduce the overall weight of my "Mountain Day" contest transceiver. The circuit was developed from a proven RTL design. Although it does not offer "squeeze keying" or dot/dash storage, it fits the needs of the beginner as well as of the high-speed brass pounder.

The dash/dot ratio remains exactly 3:1 over the whole speed range. After each dot or dash, a pause of exactly one dot length is inserted. With a 9-volt power supply, keying current is about 2 mA. When the keyer is not being operated, only about 10 nA is drawn from the supply; you may therefore connect the battery at all times and forget about the ON/OFF switch. The keying transistor switches positive voltages to ground. Changes in supply voltage have no appreciable effect on the speed. When the circuit is mounted and adequately shielded, it is not susceptible to rf pickup — even without rf chokes and bypass capacitors.

Circuit description

The schematic diagram shown in fig. 1 is divided into two main parts, the time base and dot/dash generator. The time base, a stable RC oscillator is composed of gates U1A, U2A, and U1B, plus the associated components. Dot flip-flop U3A, dash flip-flop U3B, and the summing gate U2C form the dot/dash generator. In the quiescent state, these are the logic levels: logic 1 on pin 9 of U2D (due to the AND gate formed by R5, R6, CR1, and CR2) and both flip-flops reset, providing a 1 on pin 10 of U2D. U2A and U2B form the control flip-flop for the oscillator, which is blocked by the zero from pin 3 of U2B. After a short closure of either the dot or dash contact, U2B enables the RC oscillator. (Time $t_0$ on the timing diagram, fig. 2).

The first half cycle of the oscillator places a 0 on pin 2 of U2B, thus keeping the oscillation even when the keyer lever is released. The rising edge of the first clock pulse clocks U3A to the SET state. If it was the dash contact that caused the start of the time base, a 1 from U1C would release the J input of U3B, allowing this flip-flop to be triggered by the rising edge of the pulse.

By Urs Hadorn, HB9ABO, Im Riedtli 1, CH8154, Oberglatt, Switzerland
fig. 1. Schematic diagram of the simple CMOS keyer. The speed control, R2, should have a reverse, log taper. The keyer will work with any battery supply between 3 and 15 volts. External connections are denoted by the circled terminals.

U3A’s output. In case of a dot contact closure, U3B remains reset because the zero on its J input prevents it from toggling.

The outputs of the flip-flops are summed by U2C, state. When U3A toggles back to the RESET state, the dot or dash is terminated. At this time (for dots $t_1$; for dashes, $t_2$) the clock signal is a one, maintaining oscillation for another half clock period. At this

and via the inverters drive the keying transistor. The keying signal is fed back via U2D and U1E to the control flip-flop. As long as a dot or dash is being sent, this flip-flop maintains the oscillator in the operating time ($t_3$) the voltage at terminal 1 is 1.5 $V_{batt}$, which via U1A places a zero on U2A, thereby preventing the control flip-flop from reacting to premature trigger signals. After another half dot length, the voltage

fig. 2. Timing diagram showing the levels within the keyer during the generation of a dash.
Fig. 3. The diagram of the original keying circuit in the Ten-Tec Argonaut is shown in A. To handle the saturation voltage of semiconductor keyers, the circuit was changed to the configuration shown in B. The value of the zener diode can be between 4 and 8 volts.

At terminal 1 of C has discharged to almost 0 volts. This level is transferred by U1A, as a logic 1 to the control flip-flop, which, while maintaining state, can now be triggered again by signals from the keying contacts. After this pause of one dot length, \( t_2 - t_4 \), the circuit is again in the quiescent state and ready for another dot or dash.

**transmitter connections**

Due to its small size, the keyer circuit can easily be built into virtually any transmitter or transceiver. However, a word must be said concerning the keying circuit involved. The voltage to be keyed must be positive with respect to ground. It must not exceed the voltage blocking capabilities of the keying transistor and the keyed current must be within the limits of this transistor. The keying circuit should support keying by semiconductors; with a voltage drop of up to 1 volt across the \( Q_1 \) terminals, the circuit must still operate properly. With a Ten-Tec Argonaut, this was not the case, although a minor modification according to fig. 3 solved the problem.

Transmitters with a negative-keying voltage must be modified to have a positive keying voltage. Compatibility with straight keys or relay keyers is, of course, not impaired by such a modification. Fig 4 shows the modification of a Heath HW101 as a representative of the tube transmitter family. Here are some general hints for this kind of modification: the voltage divider, \( R_7 \), \( R_8 \), and \( R_9 \), must be set up to accept a current in the range of 0.5 to 10 mA. The internal resistance of the positive and negative sources must be taken into account when the values of the resistors are determined. With the key open, the voltage at the base of \( Q_1 \) may not exceed \( V_{BE} \) maximum (4 to 8 volts, depending on \( Q_1 \)). With the key down, the voltage between \( R_7 \) and \( R_8 \) (base of \( Q_1 \) not yet connected) should be substantially more negative than the 0.7 volts needed to completely drive \( Q_1 \) into saturation.

Fig. 4. Diagram of the keying circuit of an HW101 that has been modified for this keyer. Other than \( R_7 \), \( R_8 \), \( R_9 \), and \( Q_1 \), all other components are from the original circuit.

**construction**

Circuit layout is not critical. An example of a printed circuit board layout is shown in fig. 5*. Be careful to use a polyester (or equivalent) timing capacitor. The leakage current of tantalum and aluminum electrolytic capacitors is not compatible with the high-impedance CMOS logic. In the most commonly used speed range, \( R_2 \) has a value of between 3 and 30 kohms. A potentiometer with a negative logarithmic characteristic would therefore be ideal. A standard 100-k logarithmic pot may be used instead, but the turning direction for an increase in speed would be counter-clockwise. If you insist on clockwise direction, a 100-k linear pot will do the job even if speed adjustment isn’t best.

*An etched, drilled, and plated printed circuit board is available (air-mailed to the USA and Canada) from the author for 10 sFr (USA $5.00).
fig. 5. Printed circuit board layout of the simple CMOS keyer, with the parts placement diagram shown below. The two dashed lines indicate jumpers that must be installed.

the paddle

An example of a lightweight portable paddle is shown in the photograph. The unit is connected to the transceiver by a 3-pin DIN plug whose shell is screwed to the socket in the rig. The brass lever measures $60 \times 3 \times 5$ mm ($2\frac{3}{8} \times 1\frac{1}{8} \times 3\frac{1}{16}$ inches) and is centered by the buttons of two micro switches. It is fixed to the bottom plate at the pivoting point. The lateral movement is limited by two small aluminum blocks whose distance from the lever is adjusted to allow the lever to move just slightly beyond the switching points. Although there might be more elaborate solutions to this problem, the unit has worked nicely for over a year.

Further ideas for a portable keyer paddle can be found in ref. 3 and 4, the latter being more promising according to the rule *the simpler the better.*

references


*Ham Radio*
**DSI COMMUNICATIONS SERIES**

**1.3GHz — 1GHz — 700MHz**

---

**MODEL C1000 10Hz to 1GHz**
- INCLUDES BATTERY PACK
- AUTO ZERO BLANKING
- AUTO DECIMAL POINT
- 10MHz TIME BASE

$499.95

Accuracy... that's the operational key to this rugged advanced design Model C1000 1GHz frequency counter... a significant achievement from DSI. That's because you get... 

---

**MODEL C700 50Hz to 700MHz**
- INCLUDES BATTERY PACK
- AUTO ZERO BLANKING
- AUTO DECIMAL POINT
- 10MHz TIME BASE

$369.95

ALL NEW! All UNPARALLELED DSI QUALITY! The model C 700 700 MHz frequency counter features... .2 PPM 0° to 40°C proportional oven time base... 25db preamplifier with a 60db adjustable attenuator. Built in battery charger with a rapid or trickle charge selector... Combined in a rugged (.125" thick) aluminum cabinet makes the C700 ideal for the communication industry and professional service technician.

---

**FOR MORE INFORMATION**

Call Toll Free: (800) 854-2049

DSI INSTRUMENTS, INC.

California Residents, Call Collect: (714) 565-8402

VISA • MC • AMERICAN EXPRESS • CHECK • MONEY ORDER • COD

7914 RONSON ROAD, #G, SAN DIEGO, CA 92111
ARE YOU ON FREQUENCY?
BE ON FREQUENCY WITH DSI

MODEL 3600A .5PPM 17° - 37°C
$199.95
- AUTO ZERO BLANKING
- AUTO DECIMAL POINT
- INCLUDES ANTENNA

SAVE SHOP COSTS WHEN ADJUSTING XTALS
MEET YOUR QSO ON FREQUENCY EVERY TIME

The 3600A and 3550W Frequency Counters represent a significant new advancement, utilizing the latest LSI Design which reflects DSI's ongoing dedication to excellence in instrumentation, for the professional service technician and amateur radio operator. Before you buy a DSI instrument you know what the specifications are. We publish complete and meaningful specifications which state accuracy over temperature and sensitivity at frequencies you need. And we guarantee those specifications in writing.

MODEL 3550W TCXO
$149.95
- INCLUDES INTERNAL BATTERY HOLDER
- SAME AS 3600A LESS OVEN
- SEE SPECIFICATIONS BELOW

MODEL 3700 .2PPM 0° - 40°C
$269.95
- AUTO ZERO BLANKING
- AUTO DECIMAL POINT
- INCLUDES ANTENNA

PORTABLE! TAKE IT TO THE MOUNTAINS OR USE IT MOBILE — TAKE IT WITH YOU ON FIELD DAY

ALL NEW! ALL UNPARALLELLED DSI QUALITY! The model 3700 700MHz frequency counter features . . . .2 PPM 0° to 40°C proportional oven time base . . . . Built in battery trickle charger less batteries . . . . Combined in a rugged (.125" thick) aluminum cabinet makes the 3700 ideal for the communications industry, professional service technicians, and sophisticated amateur radio operators.

3600A OWNERS: Update your 3600A frequency counter to a 3700 includes . . . .2 PPM proportional oven, rugged .125" thick aluminum cabinet, order 3600-A - 3700. Unit must be returned to DSI factory for modification.

---

### DSI — GUARANTEED SPECIFICATIONS — MADE IN USA

<table>
<thead>
<tr>
<th>Model</th>
<th>Frequency Range</th>
<th>Accuracy Over Temperature</th>
<th>@146MHz</th>
<th>@220MHz</th>
<th>@450MHz</th>
<th>Number of Readouts</th>
<th>Size of Readouts</th>
<th>Power Requirements</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>3700</td>
<td>50Hz - 700MHz</td>
<td>Proportional Oven .2 PPM 0° - 40°C</td>
<td>10MV</td>
<td>10MV</td>
<td>50MV</td>
<td>8</td>
<td>.5 Inch</td>
<td>115VAC or 8.2 - 14.5VDC</td>
<td>3&quot;H x 8&quot;W x 6&quot;D</td>
</tr>
<tr>
<td>3600A</td>
<td>50Hz - 600MHz</td>
<td>Over .5 PPM 17° - 37°C</td>
<td>10MV</td>
<td>10MV</td>
<td>50MV</td>
<td>8</td>
<td>.5 Inch</td>
<td>115VAC or 8.2 - 14.5VDC</td>
<td>2¼&quot;H x 8&quot;W x 5&quot;D</td>
</tr>
<tr>
<td>3550W</td>
<td>50Hz - 550MHz</td>
<td>1 PPM 65° - 85°F</td>
<td>25MV</td>
<td>25MV</td>
<td>75MV</td>
<td>8</td>
<td>.5 Inch</td>
<td>115VAC or 8.2 - 14.5VDC</td>
<td>2¼&quot;H x 8&quot;W x 5&quot;D</td>
</tr>
</tbody>
</table>

---

ALL UNITS ARE FACTORY ASSEMBLED, TESTED AND CARRY A FULL 1 YEAR WARRANTY —

- NO EXTRA COSTS
- FREE Shipping anywhere in U.S.A. and Canada.
- All other countries, add 10%.

Strongest warranty in the counter field. Satisfaction Guaranteed.

See Your Dealer or
Call Toll Free: (800) 854-2049
DSI INSTRUMENTS, INC.
California Residents, Call Collect: (714) 565-8402
VISA • MC • AMERICAN EXPRESS • CHECK • MONEY ORDER • COD
7914 RONSON ROAD, #G, SAN DIEGO, CA 92111

---

Model 3700 ........................................ $269.95
3600A - 3700 Factory Update (3600A Only)
Includes Labor & Re-Calibration .................. $ 99.95
Model 3600A ...................................... $199.95
Model 3550W ...................................... $149.95
Option 03 20-Hr. Rechargeable
Battery Pack ...................................... $ 29.95

---
Digital circuits are a useful and fascinating part of today’s electronics. Devices and their applications have increased by such a proportion that an amateur who is not employed in the electronics industry may be confused by the jargon surrounding the technology. This series of articles will present the basics and, it’s hoped, give you an insight into practical applications.

We are familiar with linear or “analog” circuitry, but what is a digital circuit? It is simply a decision-making device based on two voltage levels per input. The output also has two voltage levels. A two-valued input and output is called binary.

Digital circuitry (or, digital logic) is made from simple building blocks which obey specific logical rules. Interconnection of many simple blocks is possible, whether on a circuit board or a single chip of silicon. Modern technology allows an almost unlimited combination on a single chip, spawning hundreds of different digital devices. Despite their complexity of function, all digital devices are made from the basic blocks.

Several digital families exist. Differences are internal and have an effect on interfacing. The two largest families will be described: TTL or Transistor-Transistor-Logic, the bipolar family branch, and CMOS or Complementary-MOS, the fet branch. Interconnection between families is possible within certain rules.

logic level reference

Binary levels must be defined. A low level is near ground. A high level is close to the supply voltage. Some fet digital devices have more than one supply, so these refer the high level to the “Vcc” supply. The high level is assumed more positive, relative to ground or common.

Logic levels may be positive or negative. Positive logic is most common and retained throughout this series. Levels have different descriptions, so it might be well to memorize the following:

Low = 0 = near-ground = logic 0 = false
High = 1 = positive = logic 1 = true

Low, high, 0, and 1 are the most common terms. True and false may apply to devices with double outputs, one being an inverted level of the other.

A few data sheets refer to negative logic. This is generally taken as just a voltage reversal, although low and high are still the same.

basic building block

This is the gate, the fundamental decision maker. Each gate may have any number of inputs, but only one output. The six basic gates are shown in fig. 1 along with an inverter. The latter has only one input and is used mainly for level inversion.

Input states, for a specific output, will determine the type of gate. Note the small tables of 1s and 0s for each gate. These are truth tables and tell the most about a particular function. Truth tables exist for circuits and all device types; some are time dependent.

The AND gate output will be a 1 when both A and B inputs are 1. All inputs of a multiple-input gate would have to be 1 for a 1 output. The OR gate output will be 1 when any input is a 1; output is 0 only
when all inputs are 0. Exclusive-OR gates have only two inputs; a 1 on either input will produce a 1 output. But a 1 on both inputs will output a 0.

**NOT, NAND and NOR**

Compare the truth tables of the AND and NAND, OR and NOR, and the Exclusive gates of fig. 1. Each pair, of the three types, will have opposite output states. All six types are needed for design flexibility, but the NAND, NOR and Exclusive-NOR may be confusing.

Digital technology uses the term "not" when a desired signal is low; i.e., it is not high. A line named SIGNAL would be considered active (desired) when high. Renaming it SIGNAL with the overbar means it is active when low. The name SIGNAL is pronounced "signal not" or "signal bar," and either form is used.

A NAND gate output is active low. Its name comes from "not-AND." A NOR gate output is active low; its name is "not-OR." Similarly, an Exclusive-NOR is active low.

Symbol shape and little circles describe the type. Shape denotes general function while the circle or "inversion bubble" indicates an active low input or output. The bubble isn't always shown on spec sheets, so check for a device pin, name overbar, or the truth table.

The uses of NAND and NOR gates may not be apparent, so let's examine some simple gate arrays. The function of the array in fig. 2 is to provide a high output when the inputs from either A and B or C and D are both 1s. The equivalent OR function has bubble inputs, matching the active low NAND outputs. If this is confusing, go back to fig. 1 and check the state conditions of NAND input versus output. Intermediate states E and F are useful here.

NAND gates can be used for any equivalent AND-OR array cascade. Most TTL gate arrays are built up entirely of NANDs and came about through early all-transistor logic circuits. Economy in earlier days dictated a minimum number of discrete devices and resulted in inverted outputs. Designers found that all-NAND gate array cascades worked just as well as older diode gates. The first integrated circuit gates used equivalent NAND structures.

NANDs are now so numerous that an unofficial "NAND RULE" is used to analyze and design gate arrays.

**THE NAND RULE:** Any low input will cause a high output state; All inputs must be high to cause a low output state.

NAND gates used for an AND function will have active high inputs, just like an AND. The equivalent OR function requires active low inputs. Direct equivalents are shown in fig. 4. Fig. 4B is the same as an AND, while fig. 4A is the same as an OR. Inverters take care of necessary input and output state changes.

Fig. 5 is a simple array which produces a high output when either A and B are high or C input is low. Note that the overbar indicates C is active low. If conventional AND-OR gates were used, you would have C with an active high. This array shows an interesting input control condition.

Holding C low will prevent both A and B from affecting the output. Inputs A and B could then be in any state combination and the output truth table would indicate them as don't care states. Since they cannot affect the output, you don’t care what states
fig. 3. In this example, the AND/OR gates of fig. 2 have been replaced by NANDs and NORs. Even with the change, a 1 will be present at the output for the same input conditions.

they are in. An “X” on the truth table indicates the don’t care condition.

When low, the C input can be considered an inhibit for A and B. Conversely, it could be an enable input when high. Many multifunction devices have inhibit and enable inputs. A word of caution: Inhibit and enable controls may be active high or low; check the device spec sheet for bubbles and overbars.

TTL and CMOS families

TTL is the most common family. It was pioneered by Texas Instruments, and wide industry acceptance prompted all major semiconductor manufacturers to “second source” (make the same product under license) most or all devices in the original family. Their popularity resulted in other IC makers’ designing their own TTL devices; TI “second sources” many of these.

TTL is sometimes referred to as the 54/74 Series, after TI’s original numbering scheme. TI now uses an SN prefix, while other makers have different prefixes. The “54” or “74” number identifies the device. A 7400 package is a quadruple two-input NAND gate, regardless of source. Many parts lists omit prefixes, since second source devices have identical characteristics.

A “54” part is military temperature grade, –55° to +125°C. A “74” part is commercial or industrial grade, with an operating range of 0° to +70°C. There is a slight difference in operating characteristics, but this would rarely affect amateur equipment.

CMOS is the most common fet family and is ideal for low-power applications. Where TTL has internal bipolar transistors, CMOS has N-type and P-type MOSFETs in complementary arrangements. The MOSFETs are insulated-gate types with extremely high input impedance.

fig. 4. In A, since the NAND gate can be represented by an OR gate with inverters or the input, the complete OR function can be duplicated by using a NAND gate with inverters in each input. B shows the AND equivalent by using a NAND gate with an inverter on the output.

RCA developed CMOS and uses a 4000 Series numbering system with a CA prefix. CMOS is also second-sourced, but part numbers for equivalents vary; cross-reference tables are required for most second sources.

CMOS military temperature is the same as TTL, but CMOS industrial-grade temperature is –40° to +85°C. CMOS is also more lenient in power-supply voltage. TTL requires +5 volts ±5 per cent, while CMOS supply voltages can vary from 3 to 15 volts! One pays a price for such tolerances; the same device will be slower at lower voltages.

RCA also introduced “B” series CMOS (suffix to number) as an improved version of their original “A” series. The B series incorporates output buffers for driving lower loads and is characterized at 5-, 10-, and 15-volt supplies. All new designs are in the B series.

The next article in this series will take a detailed look inside the devices to point up differences between TTL and CMOS.

ham radio
Introducing

THE MODEL MT-1 MOBILE ANTENNA. TUNES 3.5 to 30 MHz INCLUSIVE. 750 WATTS P.E.P. FOR HAM BANDS, C.A.P. MILITARY, MARS, AND CB. CENTER LOADED FOR HIGH EFFICIENCY. ENABLES EXACT RESONANCE TO WANTED FREQUENCY. ALLOWS FULL OUTPUT FROM NEW SOLID STATE TRANSCEIVER FINALS. NO WORRY ABOUT REDUCED OUTPUT FROM SHUT DOWN CIRCUITS. ATTRACTIVE BLUE AND GRAY FINISH, STURDY, SOLID CONSTRUCTION, UNAFFECTED BY MOISTURE AND THE ELEMENTS. TUNED FROM THE BASE TO ELIMINATE BEND OVER OR REMOVAL FROM ANTENNA MOUNT FOR FREQUENCY CHANGE. ELIMINATES TROUBLE-SOME QUICK CONNECTORS.

JOIN THE MOBILE ACTIVITY DURING THE UPSWING OF CYCLE 21 WITH A MOBILE ANTENNA THAT PROVIDES EASE OF OPERATION AND THE UTMOST IN EFFICIENCY.

RV users: inquire about our RV extension masts — adjustable, 8 to 24 feet.

Features:

- STAINLESS STEEL WHIP
- FIBERGLASS LOADING COIL
- BASE TUNED
- LOGGING SCALE
- RESETTABLE TO EXACT FREQUENCY
- POSITIVE TUNING LOCK
- HEAT TREATED BERYLLIUM COPPER CONTACTS
- NO COILS TO CHANGE
- CORRELATION CHART FROM LOGGING SCALE TO FREQUENCY FURNISHED
- MODULAR CONSTRUCTION FOR EASY ROAD HAZARD REPAIR AND SERVICE
- 90 DAY WARRANTY — FACTORY SERVICE
- NO TUNERS OR IMPEDANCE TRANSFORMERS REQUIRED
- LESS THAN 1.8 TO 1 VSWR — ANY FREQUENCY WITHIN THE HAM BANDS, 80 THRU 10

Maximum length — 116 inches — at 3.5 MHz
Minimum length — 92.5 inches — at 30 MHz
Patents applied for.
Not an import, manufactured entirely in the U.S.A.

PRICE — $119.95

Contact your local dealer or order below

Name
Address
City
State Zip

Total

UPS Shipping $6.00
Idaho Residents Add 3% Sales Tax
Total Enclosed

Master Charge or VISA Bank No. Expiration Date

January 1979
dual-impedance headphones

The switching arrangement is shown in this view of the dual-impedance headphones. Photo by WB9CXR.

Dual-impedance headphones offer versatility, convenience, and private listening pleasure. With different types of receivers available on the market today, it is not unrealistic to have a ham-bands-only and a general-coverage receiver in the shack.

In some instances, especially with older military equipment and newer ham gear, different impedances will exist at the headphone jack. Thus, the need for a single pair of dual-impedance headphones.

Taking into account that the main source of audio was the amateur receiver (Kenwood TS-820), monaural 8-ohm headphones were purchased. The desire to listen to a military general coverage receiver meant switching headphones to provide the 600-ohm load specified in the manual.

It was not totally unrealistic to employ one pair of phones and change the impedance as desired. This was accomplished by placing a 600-to-8 ohm audio transformer in the line, switching it out for the 8-ohm load. If the components are carefully chosen (for size) they will all fit neatly into the housing of one of the phones, eliminating any external boxes. To prevent possible trouble, two double-pole, double-throw miniature toggle switches were used to completely isolate the transformer from the line.

A plastic bar was used to throw both switches at the same time. Shaped into a design of your own choosing and drilled for clearance of the bars on the switches, a drop of epoxy will hold the "throw bar" in place. Before final insertion of the bar onto the switch bats, make sure both switches are thrown in the same direction.

Jim DiSpirito, AB9Q

fig. 1. The schematic diagram in (A) shows the connections between the switches and audio transformer. T1 is a Calex DC1-724, having a 1200-ohm, center-tapped primary with an 8-ohm secondary. The switches can be ordinary miniature double-pole, double-throw switches. The small plastic throw bar is shown in (B). This bar can be shaped to fit any particular pair of headphones.

HW-2036 antenna socket

The antenna socket on the rear of the Heath HW-2036 2-meter transceiver is directly in line with a trace on the final amplifier printed circuit board. This line, which connects pin 10 on the relay and pin 2 on the plug P301, carries 13.8 volts. When using a phono plug with the long center pin, this pin will touch the board, shorting the 13.8 volts to ground. It's best to use either the RCA or Motorola style plug, since they have a shorter center pin. The phono plug/PL-259 adapter sold by Radio Shack also has the long center pin, requiring that part of it be cut off to prevent it from contacting the circuit board. However, if you wish to take the time to disassemble the transceiver, a small piece of electrical tape can be placed over the trace to prevent accidental contact.

Jim Conner, W3HCE
improved tuning on 160 meters with the T-4X transmitters

When using either a T-4XB or T-4XC transmitter below 1850 kHz, a true dip could never be obtained and loading was difficult, even when using a 50-ohm dummy load. Through discussions with other Drake owners, I found that this frustrating problem was shared by other T-4X-series transmitter owners. Being curious about this strange behaviour, we called Drake only to find that their low-end cutoff frequency is 1840 kHz. With this news, we decided to optimize the output network for the 1800-1850 kHz band, since that’s all we have in New England. The modifications are almost trivial, requiring only two capacitors in the output network and a third for the driver tank circuit, but the results are excellent. The transmitter can be loaded and controlled on the low end of 160 just the same as on any other band.

As shown in fig. 3, the modification to the output network requires the addition of a capacitor on each side of the pi network. The part numbers in parentheses apply to the T-4XC; the others, to the T-4XB. Using the pictorials provided in the Drake manual, locate S4H and C65 (C86). Add a 120-pF, 2000-volt capacitor in parallel with C65 (C86). Next, locate C67 (C89), an 865-pF capacitor on S4G, and add a 680-pF capacitor in parallel.

In addition to the output pi network, the driver tank circuit also required padding, since the driver control had to be rotated fully counterclockwise. This modification is depicted in fig. 4. A 36-pF capacitor was connected in parallel with C39 (C54), located on the rear of S4F.

With the implementation of these simple and inexpensive modifications, our Drake transmitters will load very nicely in the 1800-1840 kHz region, with the driver control showing a nice peak rather than being fully against the stop.

Steven E. Holzman, W1IBI
John D. Adamson, W1HZH

fig. 2. Schematic diagram of the changes made to the pi network to enable it to cover the low end of 160 meters. The numbers in parentheses refer to the components in the T4XC. The first designation is for the T4XB.

fig. 3. Changes made to the driver network for low end coverage of 160 meters.
SLEEP ELECTRONICS IS NOW SHIPPING...

TR-7/DR-7 TRANSCEIVER
160-10 METERS

UV-3 TRANSCEIVER
144, 220, 440

SLEEP ELECTRONICS COMPANY
HIGHWAY 441, FRANKLIN SOUTH
P.O. BOX 100, DEPT. HR-1
OTTO, NORTH CAROLINA 28763
PHONE (704) 524-7519

TR-7/DR-7 DIGITAL TRANSCEIVER .............................................. $1,295.00
PS-7 POWER SUPPLY .................................................................. 195.00
MS-7 SPEAKER ........................................................................... 55.00
RV-7 STACK VFO ........................................................................ 195.00
FA-7 FAN ..................................................................................... 25.00
AUX-7 RANGE PROGRAM BOARD ................................................ 45.00
SL-201-500, SL-1800, SL-6000 FILTERS .................................... 52.00
7077 DYNAMIC MIKE TR-7 WITH PLUG .................................... 45.00
NH-7 HF RF WATTMETER 1.8-54 MHz 2 KW ............................. 89.00
DL-1000 DRY DUMMY LOAD ....................................................... 39.95
MN-6 ANTENNA MATCH BOX 250W ........................................ 165.00
MN-2700 ANTENNA MATCH BOX 2 KW .................................... 250.00
L-46 LINEAR AMPLIFIER ............................................................. 995.00
R-4C RECEIVER ........................................................................... 699.00
T 4X TRANSMITTER ..................................................................... 699.00
AC-4 POWER SUPPLY .............................................................. 150.00
MS-4 SPEAKER ............................................................................ 33.00
UV-3 TRANSCEIVER 144-220-440 ........................................... 795.00
PS-3 AC SUPPLY UV-3 .............................................................. 89.95
TV-330L LOW PASS FILTER ......................................................... 26.60
1525EM ENCODER MICROPHONE .......................................... 49.95
6JB6 Final Tubes DRAKE MATCHED PER TUBE .................... EA. 6.50

COMPLETE STATION PACKAGE PRICES QUOTED OR TOP TRADES GIVEN IF YOU HAVE CLEAN DRAKE OR COLLINS USED EQUIPMENT.
WRITE OR PHONE BILL SLEEP (704) 524-7519 AND BUY YOUR NEW U. S. A. MADE EQUIPMENT TODAY FROM A DRAKE DEALER OF 25 YEARS. EXPORT, APO, FPO INQUIRIES ARE INVITED.

TEEE/AX PRESENTS THE FIRST COAX TOGGLE SWITCH

$39.95

Check or C.O.D.*

- Teflon Insulated
- Captivated Internal Contacts
- 52 ohms
- SPDT
- Power 1 KW
- All Brass Construction Model SW-5000 Patent Pending

* Mail Orders Accepted: Continental U.S.A. - $1.50, Elsewhere - $4.50 for Postage and Insurance

TEE/AX, INC.
5701 N.W. 31st AVENUE FT. LAUDERDALE, FLORIDA 33309
Distributor Inquiries Invited

More Details? CHECK—OFF Page 118

82 / January 1979

TPL 1/4 KILOWATT LINEAR AMPLIFIER

TPL proudly presents the first true power 1/4KW
SSB/AM, FM or CW solid state
2 meter linear amplifier
A remote control plug allows you to operate with the amplifier ON or OFF, or in SSB/AM, FM or CW from the dashboard.

The 202 utilizes the latest state of the art engineering including microstrip circuitry and modular construction. The three final transistors combine to produce 250W when driven by 15W or more at 13.8VDC.

POWER INPUT: 5-20W Carrier FM or CW 20W PEP maximum SSB or AM
POWER OUTPUT: 200-250W carrier FM or CW 300W PEP SSB or AM
FREQUENCY RANGE: 144 to 148 MHz
* will operate with slight degradation at 142 150 MHz.

HARMONIC ATTENUATION: All Harmonics Attenuated 60 dB or Greater
CURRENT DRAIN: FM-40 Amps @ 250W SSB-30 Amps @ 200W PEP
DUTY CYCLE: FM 50% @ 150W 33% @ 250W SSB 60% @ 150W 50% @ 250W

Model 2002 $499.00

can be ordered for repeater application for additional information contact

TPL COMMUNICATIONS INC.
1324 W. 135TH ST. GARDENA, CA 90247 (213) 538-9814
Canada: Lenters, Industries, Ltd., 1145 Bellamy Rd., Scarborough, Ontario M1N 1N5 Export: EMIX Inc., 2505 South 30th Avenue, Hialeah, Florida 33009
This advanced model in the M-200 Series extends the horizons of capability and performance:

- **Morse Reception:**
  6-60 wpm with automatic speed & wordspace
- **RTTY Reception:**
  4 speeds, 3 shifts, unshift on space select, automatic threshold select, auxiliary baudot loop output, tuning meter, auto. speed readout
- **ASCII Reception:**
  110 baud with built-in T.U.
- **Video Outputs:**
  32 character line x 16 line video with scrolling
- **RTTY Reception:**
  72 character line x 16 line video with scrolling
- **Special Feature:**
  ASCII, Loop or RS232 output on all modes

**Order direct or from these dealers:**

- **Advanced Electronics**
  1349 W. King Street
  Cocoa, Florida 32922
  305-631-1190

- **Cohoon Amateur Supply**
  Highway 475
  Trenton, Kentucky 42286

- **Diaita Amateur Radio Supply**
  212 48th Street
  Rapid City, S. Dakota 57701

- **Emona Electronics**
  661 George Street
  Sidney N.S.W. Australia

- **Germantown Amateur Supply**
  3202 Summer Avenue
  Memphis, Tennessee 38112
  800-238-6168

- **Ham Radio Center**
  8342 Olive Blvd.
  St. Louis, Missouri 63132
  800-325-3636

- **N & G Distributors**
  7285 N.W. 12th St.
  Miami, Florida 33126
  305-592-9685

- **Rickles Electronics**
  2800 W. Meighan Blvd.
  Gadsden, Alabama 35904
  205-547-2534

- **Universal Amateur Radio**
  1280 Aida Drive
  Reynoldsburg, Ohio 43068
  614-866-4267

- **PanaCom**
  P.O. Box 76093
  Caracas 107 Venezuela

**INFO-TECH INCORPORATED**

Specializing in Digital Electronic Systems

2349 Weldon Parkway • St. Louis, Missouri 63141 • (314) 576-5489
There's a new, eighth OSCAR satellite in orbit, and the AMSAT team helped put it there!

Your help is needed for future satellites. Join AMSAT and support the new, advanced Phase III series of OSCAR's, engineered to provide communications over transcontinental distances for hours at a time.

Send $10 membership dues to AMSAT, P.O. Box 27, Washington, D.C. 20044. Life membership is available for a tax-deductible donation of $100 or more, payable in quarterly installments if you wish.

Phase III satellite solar cells may be sponsored for $10 each, and we'll send you a certificate specifying the cells you are sponsoring.

For a tax-deductible contribution of $1,000 or more, we'll even inscribe your name on a plaque to be placed in orbit aboard the Phase III spacecraft for posterity, and we'll send you a replica honoring your contribution.

Dues and contributions may be charged to VISA or Master Charge. Phone us at (202) 488-8649.

AMSAT-OSCAR 6 Oct. 15, 1972
AMSAT-OSCAR 7 Nov. 15, 1974
AMSAT-OSCAR 8 Mar. 5, 1978

AMSAT
Radio Amateur Satellite Corporation
P.O. BOX 27, WASHINGTON, D.C. 20044
INTRODUCING THE TET MODULAR ANTENNA TOWERS

Ideal for ground or roof mounts. Modular, portable, extremely rugged.
- One man assembly and installation
- Light weight
- High quality aluminum alloy
- High stability

Finally here are strong, sturdy antenna towers that are simple to assemble, light weight, strong and can be used on your roof top, or packed up and used in the field. Available in three models: 11½', 18' and 25'. The 11½ foot model has base and one tower module; the 18 foot has two tower modules; and the 25 foot model contains three tower modules.

CALL FOR BEST PRICE!

M & M RF DISTRIBUTORS
(714) 299-9741

ORDER DIRECT FOR IMMEDIATE DELIVERY

Exclusive U.S. distributors for KEN PRO ROTATORS

KR 400—Designed for 360° rotation. Rated to support up to 200 kg or 440 lbs. Readout tolerance ± 5 degree maximum. Waterproof terminal block in rotators.

KR 500—Designed for 180° rotation. Brake holds up to 2000 kg/cm (1750 lbs/inch) torque.

KR 600—Designed for 360° rotation. Brake holds up to 4000 kg/cm (3470 lbs/inch) torque.

KR 2000—Designed for 360° rotation. Brake holds up to 10,000 kg/cm (8680 lbs/inch) torque.

We also stock the complete line of Lunar Amplifiers and Pre Amplifiers.

M & M RF DISTRIBUTORS
3360 Sports Arena Blvd. • San Diego, CA 92110 • (714) 299-9741

January 1979
Repeater of Your Dreams!
2M & 220 MHz - 450 MHz Soon

Available With Features You’ve Only Dreamed About!

Like —
- Full Autopatch, with or without Reverse patch and “Landline” or Radio Remote Control of the Repeater.
- Radio and/or Landline Touch-Tone* Remote Control of such repeater functions as HI/LO Power; Patch Inhibit/Reset; Switch ID Tracks; Repeater ON/OFF; PL ON/OFF, etc.
- 65Wt. Transmitter!
- “PL”-CTCSS; HI/LO Pwr.; Multi-Freq.; Up to 4 different IDs; Automatic switching to “Emergency Power ID” when on battery pwr.
- Ultra-sharp 10 Pole Xtal Filter; Xmr. Xtal oven — for the “ultimate” in stability.
- Timeout-Timer Reset Tone Annunciator.
- And many other “custom-designed” options per your request — such as auxiliary receivers, radio links, etc. Please Inquire.

Along with a complete line of Repeater System Accessories ... such as —
- The Finest Duplexers, Cavities, Cabinets from 7” to 7’, Antennas, “Hardline”, Cables, etc.

The SCR1000 — simply the finest repeater available on the market — absolutely Top Quality throughout ... and often compared to (lesser featured) units selling for 2 - 3 times the price! This is a 30Wt. unit, with a very sensitive & selective receiver. Included is a built-in AC Supply, NEW Expanded Memory CW IDer, full metering and lighted status indicators/control push-buttons, crystals, local mic, etc....

Join the thousands of very pleased Spec Comm customers world-wide — knowledgeable Amateur Radio groups, Commercial 2X Radio users, Military & Government Agencies, Red Cross, Universities, etc.

So, make your dream a reality ... Call or write Spec Comm today! Give us all of your repeater system requirements — whether modest ... or “Super Deluxe”, and let us send you a quote.

The Spec Comm Repeater System ... a sound, long-term investment — for those who demand the finest!

*Registered Trade Mark of A.T.&T.

A Full Line of SCR1000 Repeater Boards & Complete Sub-Assemblies Are Also Available: Inquire.

Call or write today and get the details!

Export Orders — Contact Shere in our International Department.

SPECTRUM COMMUNICATIONS
Dept. HJ — 1055 W. Germantown Park
Norristown, PA 19401 (215) 631-1710

More Details? CHECK — OFF Page 118
Model 8100
Frequency Counter Kit
- Range: 20Hz to 100MHz
- High Sensitivity
- Resolution to 0.1Hz

Now you can forget about price/performance trade-offs when you select a frequency counter. In Sabtronics' Model 8100 kit you get all the characteristics of superior performance at a low, affordable price.

This frequency counter, employing LSI technology, has the performance and input characteristics you demand: guaranteed frequency range of 20Hz to 100MHz (10 Hz to 120MHz typical); selectable hi/lo impedance; superior sensitivity; selectable resolution and selectable attenuation. Plus an accurate time base with excellent stability.

An 8-digit LED display features gate activity indicator, leading zero suppression and overflow indicator. You would expect to find all these features only on high-priced instruments - or from Sabtronics' advanced digital technology.

BRIEF SPECIFICATIONS:
- Frequency Range: 20Hz to 100MHz guaranteed, (10Hz to 120MHz typical) • Sensitivity: 15mV RMS, 20Hz to 50MHz (10mV typical); 25mV RMS, 50MHz to 100MHz (20mV typical) • Selectable Impedance: 1MΩ /25µF or 50Ω • Attenuation: X1, X10 or X100 • Accuracy: ±1Hz plus time base accuracy • Aging Rate: ±5ppm/yr. • Temperature Stability: ±10ppm, 0°C to 40°C • Resolution: 0.1Hz, 1Hz, 10Hz selectable • Display: 8-digit LED, overflow indicator, gate activity indicator • Overload Protection • Power Requirement: 9-15 VDC @ 330mA

Model 2000, 3½ Digit
DMM Kit
- 5 Functions, 28 Ranges
- Basic DCV Accuracy: 0.1% ± 1 Digit

The amazing Sabtronics 2000 is the choice of both professionals and hobbyists. It's the only portable/bench DMM that offers so much performance for such an astonishing low price.

You get basic DCV accuracy of 0.1% ± 1 digit; 5 functions giving 28 ranges; readings to ±1999 with 100% overrange; overrange indication; input overload protection; automatic polarity; and automatic zeroing.


BRIEF SPECIFICATIONS:
- DC volts in 5 ranges: 100 µV to 1kV • AC volts in 5 ranges: 100 µV to 1kV • AC current in 6 ranges: 100 nA to 2A • AC current in 6 ranges: 100 nA to 2A • Resistance: 0.12 to 20MΩ in 6 ranges • AC frequency response: 40 Hz to 50kHz • Display: 0.36" (9.1mm) 7-segment LED • Input Impedance: 10MΩ • Size: 8" W x 6.5" D x 3" H (203 x 165 x 76 mm) • Power requirement: 4.5-6.5 VDC-4" -C" cells (not included).

Special Offer! Save $25.00*
If you order both the frequency counter and DMM kits now, you pay only $144.90 including shipping and handling. You save $25.00 off the combined regular low price of $169.90. Order both kits now. This special offer good for a limited time only.

*Special offer good in USA only.

Making performance affordable.

Sabtronics International Inc. 13426 Floyd Circle Dallas TX 75243 HR-1

[Form for ordering]

More Details? CHECK — OFF Page 118
STEP UP TO TELREX
Professionally Engineered Antenna Systems

Single transmission line “TRI-BAND” ARRAY”

“MONARCH” 10, 15, 20 Meter
Model TBSEM/4KWP

ONLY TELREX GIVES YOU ALL THESE FEATURES ...
- Power rating 4 KWP ... rain or shine.
- Wind rating survival 110 mph
- Patented broad-band coaxial "Balun"
- Heavy-duty steel gusset mounting plate.
- Aluminum boom 2", 2-1/2" O.D.
- Large diameter, .058 wall taper-swaged dual elements for minimum weight and exceptional strength to weight ratio.
- Stainless steel electrical hardware.

By the only test that means anything...
on the air comparison ... this array continues to outperform all competition ...
and has for two decades. Here's why ...
Telrex uses a unique trap design employing 29 HiQ 7500 V ceramic condensers per antenna. Telrex uses 3 optimum-spaced, optimum-tuned reflectors to provide maximum gain and true F/B Tri-Band performance.

At 50 ft. or more (above ground) a rugged Telrex "Tri-Band" is the only answer to longevity ... a true money saver.

For technical data and prices on complete Telrex line, write for Catalog PL-7.

TV and Communications Antennas Since 1921

telrex LABORATORIES
P.O. Box 879 - Asbury Park, New Jersey 07712 Phone 201-775-7252

CURTIS LSI’s help you

speak MORSE

★ 8044; Keyer-On-A-Chip (Replaces 8043) ... $14.95
    Apr ‘75 HR, Feb ’76 GST, Radio Hobb ’75, Apr Hobb ’77-78
★ 8044-3; IC,PCB,Socket,Manual .................. 24.95
★ 8044-4; Semi-Kit ................................... 54.95
★ 8043; Morse Keyboard-On-A-Chip IC ........... 59.95
★ 8043-1; IC,PCB,Manual,Socket,Manual ...... 89.95
★ 8043-2; Semi-Kit ................................... 159.95
★ 8045; Instructiokey-on-A-Chip IC ............... 49.95
★ 8046-1; Semi-Kit ................................... 79.95
★ 8047; Message Memory-On-A-Chip IC .......... 39.95
★ 8047-1; IC,PCB,RAM,Manual .................. 69.95
★ 8047-2; Message Memory-On-A-Chip IC ...... 124.95
    (add $1.75 on above for postage and handling)
EK-430; CMOS Keyer (Mar ’75 GST) ............ 204.95
IK-440A; Instructokeyer* (Mar ’75 GST) ....... 224.95
    *new with dash memory as standard

NEW FROM GLB

A complete line of QUALITY 50 thru 450 MHz TRANSMITTER AND RECEIVER KITS. Only two boards for a complete receiver.
4 pole crystal filter is standard. Use with our CHANNELIZER or your crystals.
Priced from $69.95. Matching transmitter strips. Easy construction, clean spectrum, TWO WATTS output, unsurpassed audio quality and built in TONE PAD INTERFACE. Priced from $29.95.

SYNTHESIZER KITS from 50 to 450 MHz. Prices start at $119.95.

Now available in KIT FORM — GLB Model 200 MINI-SIZER.
Fits any HT. Only 3.5 mA current drain. Kit price $159.95 Wired and tested. $239.95
Send for FREE 16 page catalog.
We welcome Mastercharge or VISA

GLB ELECTRONICS
1952 Clinton St., Buffalo, N.Y. 14206

88 January 1979

More Details? CHECK—OFF Page 118
HEATHKIT® Amateur Radio Gear...
with the quality that measures up!

Hand-Held 2-Meter Transceiver with a full 2 watts power

VF-2031

Totally Broad-banded. All Solid-State CW/SSB

SB-104A Transceiver

Heathkit Amateur Radio equipment has long been the favorite of Hams the world over because it provides the performance, specifications, dependability and long-term reliability that Hams are looking for. It should. It's designed by Hams, for Hams. For more than 25 years, Heath has been making fine Amateur Radio equipment. It's no surprise that Hams have come to expect Heath's experience and knowledge to translate into some of the finest equipment around.

For instance, our new VF-2031 2-meter Transceiver. It's portable, practical and it gets you on two with a clean, clear signal that really gets out! It has a minimum 2 watts out, separate speaker and microphone for outstanding audio quality, eight crystal-controlled channels and 600 kHz offset for a total of 8 receive and 24 transmit channels for real 2-meter versatility. A complete list of options includes auto-patch and tone encoders, external mike and holster-style leather carrying case. And at just $189.95 in kit form, we don't think you'll find a better all-around hand-held!

Then there's our world-famous SB-104A, a superior SSB/CW transceiver, the "heart" of any first-class station. Totally broad-banded, all solid-state, with TRUE digital readout – it's THE transceiver for the serious Amateur. And now, with it's completely re-engineered front-end receiver board and transmitter IF, which are supplied factory assembled and tested, you can get on the air faster and better! For just $699.95 and a few evenings of kitbuilding, you'll have a rig that compares with equipment costing hundreds of dollars more! And, of course, there's a full line of accessories to add convenience and versatility to your SB-104A station.

There's more for the Ham at Heath.

FREE
HEATHKIT CATALOG
Send for yours today!

Read about our entire line of Amateur Radio Equipment including linear amplifiers, antennas, mikes, wattmeters and more! If coupon is missing, write Heath Company, Dept. 122-490, Benton Harbor, Michigan

*Prices are mail order only. Shipping and handling extra. Call for details.

P.S. You may receive a Heathkit catalog from time to time. If you prefer not to receive these catalogs, please check this box.

Name ____________________________
Address ____________________________
City __________________ State __________
AM-384 Zip __________

Heath Company, Dept. 122-490
Benton Harbor, MI 49022
All Palomar Engineers products are made in U.S.A. Since 1965, manufacturers of Amateur Radio Equipment only.

- New device opens up the world of Very Low Frequency radio.
- Gives reception of the 1750 meter band at 160-190 KHz where transmitters of one watt power can be operated without FCC license.
- Also covers the navigation radiobeacon band, standard frequency broadcasts, ship-to-shore communications, and the European low frequency broadcast band.

The converter moves all these signals to the 80 meter amateur band where they can be tuned in on an ordinary shortwave receiver.

The converter is simple to use and has no tuning adjustments. Tuning of VLF signals is done entirely by the receiver which picks up 10 KHz signals at 3510 KHz, 100 KHz signals at 3600 KHz, 500 KHz signals at 4000 KHz.

The VLF converter has crystal control for accurate frequency conversion, a low noise rf amplifier for high sensitivity, and a multipole filter to cut broadcast and 80 meter interference.

All this performance is packed into a small 3" x 1 1/2" x 6" die cast aluminum case with UHF (SO-239) connectors.

The unique Palomar Engineers circuit eliminates the complex bandswitching and tuning adjustments usually found in VLF converters. Free descriptive brochure sent on request.

Order direct. VLF Converter $55.00 in U.S. and Canada. Add $2.00 shipping/handling. California residents add sales tax.

Explore the interesting world of VLF. Order your converter today! Send check or money order to:

Palomar Engineers
Box 455, Escondido, CA. 92025 • Phone: [714] 747-3343

Regency Scanner
BRINGS YOU THE NEWS WHILE ITS HAPPENING

10 channels covering all 5 bands. AC/DC operation.

SAVE *$40 $89.95
LIST *$129.95

1,000's OF CRYSTALS
- H25C Case Scanner Monitor
- 10.7 MHz Amateur Ham
- 2 Meter, CB, Standard

1 to 9 $3.70
10 to 49 $3.00
50 and up $2.50

CRYSTAL BANKING SERVICE
P.O. BOX 683
LYNNFIELD, MASS. 01940

FT-227 "MEMORIZER" OWNERS: SCANNER KIT

- Selectable sweep width (up to full band)
- Scans only the portion of band you select
- Scans at the rate of 200 kHz per second
- Switch modification on mike allows you to scan past, or lock on, any occupied frequency
- Complete kit with detailed instructions
- Installs inside rig; no obtrusive external connections
- Rig can easily be returned to original condition whenever desired
- Scans to preset limits and reverses
- Automatic bypass of locked frequency in 3-1/2 seconds unless you press lock-on switch

Kit $34.95 preassembled and tested $54.00
add $1.50 postage and handling

IC-22S Scanner Kits also available
Kit $34.95, $54.00 assembled.
add $1.50 postage and handling

dealer inquiries invited

AED ELECTRONICS
750 LUCERNE RD., SUITE 120
MONTREAL, QUEBEC, CANADA H3R 2H6
TEL. 514-737-7293

90 January 1979
EXPERIENCE. There’s no substitute for it. And TEN-TEC has it. More experience in solid-state HF technology than any other amateur radio manufacturer. Because TEN-TEC produced the first all solid-state HF transceiver for amateur radio. So, it stands to reason that the latest generations (the 540/544 models) benefit the most from that experience — in features, reliability, and operating ease. They are the “voices of experience.”

TAKE MECHANICAL DESIGN. Experience tells us: make it rugged. So, like all fine solid-state devices such as computers and good test equipment, the 540/544 transceivers have their strength built into the chassis — the case is merely a cover. Ruggedness is carried over into the circuit boards as well. Component leads are “clinched,” not just inserted, to give additional strength and to prevent annoying intermittents.

TAKE PHYSICAL APPEARANCE. Experience tells us: keep it simple. WWII is over, so is its technology, so why should your transceiver look like war surplus? The 540/544 transceivers look like tomorrow — small because technology makes it possible — few controls for the same reason. And they’re elegantly handsome with black cases and brushed aluminum front panels.

TAKE ELECTRICAL DESIGN. Experience tells us: push the state-of-the-art. Example: we pioneered high power solid-state design for HF amateur radio gear. The advantages are numerous: efficient, small size, no lethal voltages, less heat, longer life, greater reliability. Example: broadband design. The advantages: easier operation for everyone, rag-chewers, DX chasers, even net operators. No out of reasonance danger, no need for a dummy load to prevent tune-up QRM, no boring, time-consuming “tune-up” procedures. Another example: computer aid. In circuit design, in manufacturing, for speed and optimization. Example: computer compensating oscillator drift to achieve rock-like stability.

TAKE SERVICING. Experience tells us: make it easy, for everyone. So the 540/544 transceivers have modular design with plug-in circuit boards. And trouble-shooting (if it’s ever needed) can be done by you with ordinary test equipment. (Of course, Ten-Tec service people are ready to help).

TAKE OPERATING CONVENIENCE. Experience tells us: everyone wants it. Examples: high sensitivity with low internal noise makes the 540/544 transceivers great for DX, especially during poor band conditions. Full-break on CW turns conventional QSOs into interesting conversations. Pre-selectable ALC gives automatic level control at various input powers (40-200 watts) plus optimized input power for linear amplifiers. “Semi-hard” keying effectively penetrates pileups, QRM, and QRN, yet is highly articulate and pleasant to copy. Pulsed calibrators are easy to identify. VOX that eliminates “anti-VOX” by triggering on a tone present in your voice but not in the transceiver speaker. (There are even more conveniences in the following “features” list.)

FEATURES — Instant Band Change (no xmr. tune-up) • Covers 3.5 to 30 MHz (plus One-Sixty with option) • 200 Watts Input — all bands • Receiver Sensitivity 0.3 uV • VFO changes less than 15 Hz per F0 after 30 min. warm-up • 8-pole Crystal IF Filter • Direct Readouts — choose LED digital model or 1 kHz dial model • Optional 150 Hz CW filter • Optional Noise Blanker • Offset Tuning • WWV at 10 & 15 MHz • Separate Receive Capability • Automatic Sideband Selection, Reversible • Sidetone Level and Pitch control • Pre-Setable ALC • 100% Duty Cycle • S Meter and SWR Bridge • LED indicators for ALC and OFFSET • Modular Plug-In Circuit Boards • Broad Accessory Line

544 Digital — $869 540 Non-Digital — $699

Give your voice the Ten-Tec “Voice of Experience” treatment. See the 540/544 transceivers at your Ten-Tec dealer or write for full details.

THE VOICE OF EXPERIENCE

TEN-TEC, INC.
SEVIERVILLE, TENNESSEE 37862
EXPORT SITES: LINCOLN AVE., HAYMARKET, VA.; DULUTH, MINNESOTA.
START THE NEW YEAR
WITH A COPY OF
GREGORY ELECTRONICS
NEW 1979
CATALOG

WHERE THE HAM
IS KING
SERVICE FOR
OVER 30 YEARS

DEALERS WANTED

Hamtronics, Inc. is a stocking distributor for all major lines of Radio Communications Equipment, parts and accessories.

If you are presently in the electronics sales and service business, and have experienced difficulty in maintaining proper inventory to serve your customers or if you are contemplating going into your own business, we may be able to solve your problem with our large inventory.

For more information fill in coupon below and mail today with your letterhead or Tax Exempt Number.

THE S-F REJEKTOR FILTER
AN INTEGRATED CIRCUIT
ACTIVE BANDPASS FILTER
FOR PROCESSED RECEIVER AUDIO
- Separate active filter elements for CW and SSB audio output stage
- 8 cm input and output impedance
- Headphone jack for convenience
- ON CW: from 500 Hz to 100 Hz, variable
- ON SSB: 2 KHz fixed bandwidth
- Rejects unwanted signal better than 60 dB
- Designed for today’s transceivers or yesterday’s older equipment $49.50

*WELL KNOWN DXP WITH OVER 500 COUNTRIES CONFIRMED
All prices postpaid - In Calif., add $5 sales tax - Mastercharge & Visa accepted
SATISFACTION GUARANTEED OR MONEY REFUNDED

More Details? CHECK — OFF Page 118
YOU ASKED FOR IT
YOU GOT IT
DSI
QUIK-KIT®

550 MHZ COUNTER KIT
Performance You Can Count On

DSI OFFERS THE BEST OF TWO WORLDS . . .
An unprecendented DSI VALUE . . . in a high
quality, LSI Design, 550 MHZ frequency counter
kit. And, because it’s a DSI innovation, you know
it obsoletes any competitive makes, both in price
& performance. The basic 550 MHZ counter & time
base are factory assembled, tested and burned-in.
The problems of bad LEDS, IC’s, capacitors,
are a thing of the past with DSI QUIK-KIT®. But you
can take pride in assembling the power supply, PC
mounted selector switch, input connectors, and the
final mechanical assembly of your 550 MHZ
counter, into its’ handsome cabinet. GO WITH THE
LEADER . . . BUY A DSI FREQUENCY COUNTER
KIT. SAVE TIME & MONEY AND BE ASSURED
IT WILL WORK THE FIRST TIME.

OPERATES ON
• Batt 6-C Size
• DC 8.2 To 14.5 VDC
• AC Batt. Eliminator

$99.95
MODEL 3550 KIT

SPECIFICATIONS
Time Base TCXO 1PPM 65° to 85°F
Frequency Range 50HZ to 550MHZ
Resolution 1HZ to 55MHZ, lOHZ to
550MHZ
Gate Time 1 second - l/10 second
Sensitivity 25MV 150 & 25OMHZ
Display Eight 1/2-inch LEDS
Input Two SO239 Connectors
Power 6C-Size Batt., 15HR, or 8.2VDC to 14.5VDC
Current 150 Ma standby 300 Ma operational

3550 KIT INCLUDES
• Pre-assembled, tested counter board
• Case, power supply, connectors, hardware
• Built-in prescaler & preamp
• Gate Light - Automatic Zero Blanking
• Automatic Decimal Point
• One to two hours assembly time
• One Year Warranty on all parts
• All new parts - not factory seconds or surplus

SEE YOUR LOCAL DEALER
OR
CALL TOLL FREE (800) 854-2049
California Residents, Call Collect (714) 566-8402
DSI INSTRUMENTS, INC.
7914 Ronson Road No. G, San Diego, CA 92111

TERMS: Orders to U.S. and Canada, add 5% to minimum of $10.00 per order
for shipping, handling and insurance. To all other countries, add 15% of total
order. California Residents add 6% State Sales Tax.
NEW – NEW – NEW from DATA SIGNAL

TOUCH TONE® MICROPHONE

DataCoder 5

$39.00

JUST LOOK AT THESE FEATURES:

- Tough "Mobile Environment" Microphone
- Positive Action Tactile Keys
- High-impedance Ceramic or 500-ohm Dynamic Cartridge
- Adjustable Tone Balance and Output Level
- "Positive Hold - Easy Lift" Hanger
- For Vehicle or Hand-held Portable Use
- Complete . . . Not a Kit . . . $39.00

MINIATURE ENCODERS

DTM


SUB-MINIATURE ENCODERS

MODEL SME — Smallest available Touch Tone Encoder. Thin only .05" thick, keyboard mounts directly to front of hand-held portable, while sub-miniature tone module fits inside. This keyboard allows use of battery chargers. Price SME - $29.00, with your choice of keyboards. SME (less keyboard) $139.00

DATA SIGNAL, INC.

2403 COMMERCE LANE
ALBANY, GEORGIA 31707, 912-883-4703

Be sure to ask about our new keyers and CW memory for CW buffs.

"THE PROFESSIONALS"

NEW MODEL COUNTERS

NEW

Model CTR-2A • 500 MHz

& 1 GHz

NEW Period Measurement

1 use to 1 sec.

The New Model CTR-2A Series Counters are designed and built to the highest standards to fulfill the needs of commercial communications, engineering labs and serious experimenters. With an accuracy of + .00005% (oven option) the CTR-2A can handle the most critical measurements and is about half the cost of other commercial counters.

If you need a reliable counter at an affordable price, the CTR-2A is the answer.

• Built-in Pre-Amp 10 mv @ 150 MHz
• 8 Digit .3" LED Display
• High Stability TCXO Time Base
• Built-in VHF-UHF Prescaler
• Automatic Dp Placement
• TCXO Std. ± 2 ppm
• Period Measurement (Optional)
• Input Diode Protected
• 12V-DC Operation (Optional)
• Oven Controlled Crystal (Optional)
• Selectible Gate Times - 1 & 1 sec.

500 MHz Kit CTR-2A-500K
$249.95
500 MHz Assembled CTR-2A-500A
349.95
1GHz Kit CTR-2A-1000K
399.95
1GHz Assembled CTR-2A-1000A
549.95

OPTIONS . . . .

02) Oven Crystal $49.95
03) .43" LED 10.00
04) 12 V-DC 10.00
05) 10 sec. Time Base $ 5.00
06) Period 15.00
07) Handle 10.00

PROBES

Hi-Z $15.00
Low Pass $15.00

Send 10" for our latest catalog
Write or phone for more details
2400 Crystal Drive
Ft Myers, Florida 33901
all phones (813) 936-2397

JAN CRYSTALS

KEEP YOU ON THE AIR

• CB
• CB standard
• 2 meter
• Scanners
• Amateur Bands
• Micro processor crystals

easy to charge

$15.00

DAVIS ELECTRONICS 636 Sheridan Dr., Tona., N.Y. 14150 716/874-5848

DAVIS CRYSTALS

January 1979
KENWOOD — TR7600A

Beat the high cost of Deluxe 2 meter operation

Remote Controller (option)
- Stores
- Scans
- Reads Out Frequency
(CALL FOR QUOTE)

MML 144/100, 100 WATT 144 MHz LINEAR POWER AMPLIFIER

- 80 Watts Minimum Output
- Fully Protected Against Poor Load VSWR, Overheating and Excessive or Reverse Supply Rails
- Equipped with RF VOX and Manual Override
- Supplied with Power Lead and All Connectors

CALL FOR FAST QUOTES
SPECIAL ORDERS WELCOME

WINTER WONDERS

OMNI-L & heavy duty magnet mount complete $49.95
GRIEX W5 FT Self Support Tower (Reg, $825.00) $725.00
Tonna 9FT Antennas 144/16el $79.95
RIW 432/19el $59.95
KLITZING VHF-UHF Amplifiers
2M 10W In — 100W Out $198.00
432 10W In — 50W Out $198.00
BIRD 43 & Stigs. UPS Paid Stock
Microwave Modules 432-285. UPS Paid $329.00
Telrex TBE-9M, In Stock $415.00
NEW Palomar Engr Transceiver Preamp $69.50
Bencher Paddles $39.95; Chrome $49.95
ETO 76 Amplifiers Stock
Lumin 6M-2M 220 In Line Preamps $49.95
Lunar 2M Amp 10-80 with Preamp, UPS Paid $189.95
Jenal QSA-5 Stock
CDE HAM-3 ... $129.00; HAM-X $249.00
VHF Engrs. blue line amps Stock
Getron 572B $27.95
Raytheon 572B $24.95
Motorola HEP 170 $0.29 ea.
Mallory 2.5A1000IV Epoxy Diode $0.19 ea.
Aerovox 1000PF/500V Feed thru $1.95
GE 6146B or 8950 $7.95
Technical books: AMECO, ARRL, Sams, TAB, Rider, Radio Pub, Callbook, Cowan, many others Call
NEW BELDEN 9405 (216) (6418) B wire Rotor Cable...
heavy duty for long runs... $0.26/ft.
844B. Std. 8-wire Rotor $0.16/ft.
9888. double shield RGB Foarn $0.39/ft.
8214. RGB Foam $0.25/ft.
8237. RG-8 $0.21/ft.
8267. RG-213 $0.25/ft.
Amphenol Silver Plate PL259 $0.59
TIMES "A" Foam Hardline $0.60/ft. Connectors $15.00 ea.
7/8" Hardline $1.50/ft. Connectors $25.00 ea.
BERKTEK RG-8X. 52 ohm. $0.16/ft.
Consolidated HD-18 Ga. Galv. Tower. 10" Sec $29.95
Robot "Slow Scan" Now In Stock Call
Alliance HD73 Rotor $109.95
Teletower - self support - 55 ft/114 breakover $499.00

LATE SPECIAL: All FINCO Amateur Antennas — 10% off/last in stock

THIS MONTH'S SPECIAL
ICOM IC280 — $395.00
DENTRON GLA1000 Amplifier — $319.00

16 ELEMENTS — F9FT — 144 MHz

The 'Tonna' You've been hearing about

144/146 MHz SWR 1.2:1
50 ohms Wt. 4.4 kg.
length 6.4 m. Horiz./Vert.
Side lobe attenuation 60 dB
Horizontal aperture $2 x 16° (-3 dB)
Vertical aperture $2 x 17° (-3 dB)

$79.95
9 Element 144-146 $39.95
4 Element 144-146 $32.95

TERMS: All prices FOB Houston. Prices subject to change without notice.
All items Guaranteed. Some items subject to prior sale. Send letterhead for
Amateur dealers price list. Texas residents add 6% tax. Please add
postage estimate.

W5GU. W5MBB, K5A3K. N5JU, W5JJ, AG5K. WD5D. KS5D. WD5ABR.
éstq. WD5BGX. W5RPYF, K5HC, K5RGB.

MADISON ELECTRONICS SUPPLY, INC.
1508-D Mckinney • HOUSTON, TEXAS 77002
713/658-0268

Have A Nice Day! *
D.LA.
Join the
YAESU-
KENWOOD
CROWD!

250 & 400 Hz 8-pole xtal filters
WIN YOUR BATTLE AGAINST ORM
GET THE BEST AND SAVE

ONLY $55
AIRMAIL POSTPAID
OVERSEAS ADD $3

"Fantastic!" is the word K2TK uses in summarizing the performance of the new Fox-Tango 8-pole 250 Hz CW crystal lattice filter in comparison with that of his standard 4-pole Heath unit. "Remarkably free from ringing...exceptional ultimate rejection...superior shape factor...easy installation...." are other quotes from his enthusiastic report. While grating, his remarks come as no surprise — they merely echo those of hundreds of satisfied Yaesu and Kenwood purchasers of Fox-Tango filters who have decided to up-grade their present sets instead of purchasing new ones at today's inflated prices.

Fox-Tango filters are designed to match the mounting holes in the most popular Heath rigs like the HW-101, SB-301, etc., exactly. For the others, the drilling of a few small holes will pose no problem for Heath owners who have "built their own". K2TK mounted his new 250 Hz unit in the space reserved for an AM filter in his SB300 thus making use of existing front panel controls for selecting either of his two CW filters. For those whose models lack this facility, it will be easy to improvise mechanical or electromagnetic switching arrangements if dual filters are desired. Of course, for those satisfied with one filter, installation usually consists of tightening two nuts and soldering two connections.

Our complete line of filters is listed below. Note that we offer both 250 and 400 Hz bandwidths for Heath rigs. Although the latter appears to be the same as the standard Heath CW filter, the difference in 8-pole performance has to be heard to be believed. The 400 Hz unit is ideal for routine CW operation even though it lacks the needle-sharp response (and critical tuning requirements) of the 250 Hz filter.

All units are $55 except as indicated. Order with confidence — satisfaction is guaranteed.

<table>
<thead>
<tr>
<th>Rig No.</th>
<th>Filter No.</th>
<th>Used for</th>
<th>Center Freq.</th>
<th>No. of Poles</th>
<th>Band Width</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>25K250</td>
<td>CW</td>
<td>317.9</td>
<td>8</td>
<td>250 Hz</td>
<td>Use instead of standard 600 Hz unit</td>
<td></td>
</tr>
<tr>
<td>31H500</td>
<td>CW</td>
<td>317.9</td>
<td>6</td>
<td>600 Hz</td>
<td>Same as standard XF-200 unit</td>
<td>$45</td>
</tr>
<tr>
<td>31H5C</td>
<td>CW</td>
<td>318.0</td>
<td>8</td>
<td>1.6 kHz</td>
<td>For narrow SSB to reduce ORM</td>
<td></td>
</tr>
<tr>
<td>31H5C</td>
<td>SSB</td>
<td>318.0</td>
<td>2.4 kHz</td>
<td>For use in speech processor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>31H5C</td>
<td>AM</td>
<td>318.0</td>
<td>6.5 kHz</td>
<td>Same as standard XF-200 unit</td>
<td>$45</td>
<td></td>
</tr>
<tr>
<td>25K250</td>
<td>CW</td>
<td>399.9</td>
<td>8</td>
<td>250 Hz</td>
<td>Use instead of standard 600 Hz unit</td>
<td></td>
</tr>
<tr>
<td>31M5C</td>
<td>CW</td>
<td>399.9</td>
<td>8</td>
<td>600 Hz</td>
<td>For narrow SSB to reduce ORM</td>
<td></td>
</tr>
<tr>
<td>31M5C</td>
<td>SSB</td>
<td>3900.0</td>
<td>8</td>
<td>2.4 kHz</td>
<td>For use in speech processor</td>
<td></td>
</tr>
<tr>
<td>31M5C</td>
<td>AM</td>
<td>3900.0</td>
<td>6.5 kHz</td>
<td>Same as standard XF-200 unit</td>
<td>$45</td>
<td></td>
</tr>
<tr>
<td>25K250</td>
<td>CW</td>
<td>898.3</td>
<td>8</td>
<td>250 Hz</td>
<td>Use instead of standard 600 Hz unit</td>
<td></td>
</tr>
<tr>
<td>31M5C</td>
<td>CW</td>
<td>898.3</td>
<td>8</td>
<td>600 Hz</td>
<td>For narrow SSB to reduce ORM</td>
<td></td>
</tr>
<tr>
<td>31M5C</td>
<td>SSB</td>
<td>3335.5</td>
<td>8</td>
<td>2.4 kHz</td>
<td>For use in speech processor</td>
<td></td>
</tr>
<tr>
<td>31M5C</td>
<td>AM</td>
<td>3335.5</td>
<td>6.5 kHz</td>
<td>Same as standard XF-200 unit</td>
<td>$45</td>
<td></td>
</tr>
<tr>
<td>25K250</td>
<td>CW</td>
<td>883.0</td>
<td>8</td>
<td>250 Hz</td>
<td>Use instead of standard 600 Hz unit</td>
<td></td>
</tr>
<tr>
<td>31M5C</td>
<td>CW</td>
<td>883.0</td>
<td>8</td>
<td>600 Hz</td>
<td>For narrow SSB to reduce ORM</td>
<td></td>
</tr>
<tr>
<td>31M5C</td>
<td>SSB</td>
<td>3335.5</td>
<td>8</td>
<td>2.4 kHz</td>
<td>For use in speech processor</td>
<td></td>
</tr>
<tr>
<td>31M5C</td>
<td>AM</td>
<td>3335.5</td>
<td>6.5 kHz</td>
<td>Same as standard XF-200 unit</td>
<td>$45</td>
<td></td>
</tr>
<tr>
<td>25K250</td>
<td>CW</td>
<td>3394.5</td>
<td>8</td>
<td>250 kHz</td>
<td>Use instead of standard Heath CW filters</td>
<td></td>
</tr>
</tbody>
</table>

To avoid error due to similarity of some filter numbers, specify desired unit completely when ordering. Include make and model of set, filter number, and center frequency.

Diode Switching Boards permit easy mounting (without drilling) of up to two crystal filters of any type in addition to those for which the manufacturer provides space. These boards will accommodate any of the filters listed except Heath. Specify make of set with which board is to be used. $20 airmail postpaid.

VISA and Master Charge accepted.

January 27-28, 1979

ARRL Convention
& 19th Annual
TROPICAL HAMBOREE.
FLAGLER DOG TRACK
Miami, Florida

FREE PARKING
INCLUDING OVERNIGHT SPACE FOR
COMPLETELY SELF-CONTAINED RV's

Pre-Registration
$3.00
P.O. Box 350045, Riverside Sta.
Miami, Fla. 33135

MORE DETAILS? CHECK—OFF PAGE 118
FREQUENCY COUNTER KIT
Outstanding Performance
Incredible Price
$89.95

The CT-50 is a versatile and precision frequency counter which will measure frequencies to 60 MHz and up to 600 MHz with the CT-600 option. Large Scale Integration, CMOS circuitry and solid state display technology have enabled this counter to match 600 MHz in units selling for over three times as much. Low power consumption (typically 300-400 ma) makes the CT-50 ideal for portable battery operation. Features of the CT-50 include large 8 digit LED display, RF shielded all metal case, easy pushbutton operation automatic ON/OFF +/-. The clock display is protected to 50 volts to insure against accidental burnout or overload. The base unit is not the assembly. Clear step by step instructions guide you to a finished unit you can rely on.

Order your today
CT-50 60 MHz counter kit $89.95
CT-50VT 60 MHz counter and tested $129.95
CT-600 600 MHz option. $29.95

--

OP-AMP SPECIAL

CF-1 Color TV calibrator-stabilizer $14.95
DP-1 DC probe, general purpose probe $12.95
HP-1 High impedance probe, non-load $13.95

FM MINI MIKE KIT
A super high performance FM wireless mike kit Transmits a stable signal up to 300 yards with exceptional audio quality by means of its built in equalizer kit includes case, on-off switch, antennae, battery and super instructions. This is the best unit available.

FM-3 kit $12.95
FM-3 wired and tested $16.95

CLOCK KITS

---

FM WIRELESS MIKE KIT

Transmits up to 300' to any FM broadcast radio, uses any type of mike. Runs on 2 AA batteries. $12.95
FM-2 kit $4.95

COLOR ORGAN/MUSIC LIGHTS

See music come alive! 3 different colors flicker with music. One channel features 12 songs, the other 8 songs. Each channel individually adjustable and drives up to 3000 Watt for parties, band music, ride clubs etc. Complete kit. ML $7.95

SIREN KIT
Police sounder and downward wall characteristic of a police siren.外接 speaker output, runs on 3.5 volt, uses 3.0 volt speaker. Complete kit. GM $2.95

SUPER SLEUTH
A tv/sound detector, will pick up pin drop at 15 feet range. Great for monitoring baby's room etc. Complete kit. $6.95

TOY CODER
A complete decoder on a single PC board. Features: 4000-5000 Hz. All 4000-5000 Hz range. Used to detect tone-burst detection. KS2 etc. Can also be used as a stable tone decoder. Runs on 5 to 12 volts complete kit. $5.95

POWER SUPPLY KIT
Complete regulated power supply provides variable 6 to 18 volts at 200 mA and 5 volt. Amp. Excellent load regulation, good filtering and stable. Less transformers requires 9 V or A and 24 VCT. Complete kit. PS-3LT $6.95

VIDEO MODULATOR KIT
Converts any tv/sound detector. Super stable, tunable over ch. 4-8 runs on 5-15v accepts std. video signal, best on the market. Complete kit. $6.95

RECORDABLE SPACE SOUND KIT

A complete decoder on a single PCB. Features: 4000-5000 Hz. All 4000-5000 Hz range. Used to detect tone-burst detection. KS2 etc. Can also be used as a stable tone decoder. Runs on 5 to 12 volts complete kit. $5.95

COLOR ORGAN/MUSIC LIGHTS

See music come alive! 3 different colors flicker with music. One channel features 12 songs, the other 8 songs. Each channel individually adjustable and drives up to 3000 Watt for parties, band music, ride clubs etc. Complete kit. ML $7.95

WHISPER LIGHT KIT
An all-in-one kit, small mix picks up sounds and converts it to light. The louder the sound the brighter the light. Complete self-contained includes: mix, runs on 110/120VAC, controls up to 300 watts Complete kit. WL-1 $6.95

LED Blinky Kit
A great attention getter which alternates 2 green LEDs use for name badges, buttons, warning/panel lights, anything. Runs on 3-4 volts. Complete kit. BL-1 $2.95

More Details? CHECK — Off Page 118

January 1979
NOT A KIT
the microcomputer controlled appointment clock

A NEW SOLUTION FOR SOME OLD PROBLEMS
Your schedule will never be upset with you for
missing a birthday. Your business associates will be pleased when
you're never late for appointments. Your doctor will be confident that you are
taking your medication at the time pre-
scribed.

FOR THE BUSY EXECUTIVE
Controls length of business meetings. Reminds you 15 minutes ahead of time to
prepare for meeting and gives you time to
clear your desk. Reminder of wife's birth-
day. Reminder to catch planes for important
business trips.

FOR THE HOMEMAKER
Reminder to take meat out of freezer for din-
er. Kitchen timer. Reminder of term dates
and hair dresser appointments.

FOR THE MOTHER
Time children's phone calls, homework
music practice. Wake children for school.

FOR THE SENIOR CITIZEN
Medical reminder. Reminder of grand-
children's birthdays, doctor appointments
Fast-to-read large display. A wonderful gift
for Dad and Mom.

FOR THE STUDENT
Timer for chemistry lab, bio lab. Timer for
solving problems or preparation for exams.

FOR THE GOURMET COOK
Alarms to tell you when to start next step in
meal preparation. By programming the timer
alarm, you'll know just when each course of
an elaborate meal must be prepared so
everyone will be ready at the same time.
Hints you keep track of recipe timing.

FOR THE SALESMAN
Stops up to 20 future appointments — easy
to see at the touch of a key when next
appointment is scheduled.

FOR THE PHOTOGRAPHER
Timer for photographic development chain
Can insert red digital display filter to avoid
camouflage film.

FOR THE ATTORNEY
Records client's time charges, meetings,
phone calls, research. Timer with built-in
pause capability provides accurate way of
timing speech presentations.

FOR THE SECRETARY
The secretary's best friend. Remembers to
remind the boss of key appointments. Times
length of phone calls.

Regular Price $79.95
Introductory Offer
By Hal-Tronix
only $69.95

TITETRAC FEATURES
- Sleek modern styling to complement any
home or office decor.
- Tells the time.
- Tells the date and year.
- Up-timer to 60 minutes, 59 seconds with
pause.
- Alarm to ring at the same time, everyday.
- Daily appointment sets appointments for
the next 23 hours, 59 minutes.
- Future appointments up to one year.
- Dimmer switch for display.
- Memory will hold up to 30 appointments.
- Lithium power cell to retain memory
during power outage.
- Appointments entered out of
chronological order will be stored in
chronological order.
- Colon flashes once each second.
- A.M./P.M. indicator.
- Plug into any wall outlet.
- Easy to read vacuum fluorescent
display.
- Extremely accurate quartz crystal clock.

THE TITETRAC COMPUTER
APPOINTMENT ALARM.
Efficient! Remarkable!
Ask your salesman for a demonstration.

THE ONLY CLOCK OF ITS KIND —
NONE CAN COMPARE!

RELAX AND LET TITETRAC
DO YOUR REMEMBERING.
TITETRAC helps manage your busy
schedule, increases your efficiency. Every
home and office needs TITETRAC.

TITETRAC — THE CLOCK
THAT REMEMBERS.
This is the exciting, all new time-manager that
combines space-age technology with every-
day practicality. It remembers and reminds
you of everything that you might forget.
TITETRAC combines smart, modern design
with precision and performance. Its vacuum
fluorescent display provides readability from
a distance (the largest display on the market
today). You control the display brightness
with a dimmer switch.

Send 15¢ Stamp or S.A.S.E. for Information
and Flyer on Other Hal-Tronix Products.
To Phone Order in 1-313-285-1782.
VISA and Master Charge Accepted.

SUB-AUDIBLE GENERATOR
for FM
- Inexpensive multi-
tone encoder
- Compatible with
PL-CG-OC
- Low distortion
sinewave
- Input 8-18 VDC
unregulated
- Rugged, plastic
encased with
leads
- Adjustable frequency
(98-250 Hz), Lower
available
- Excellent stability
Send for more info

HI-Q BALUN
- For dipoles, yagis, inverted
V, doublet & quads
- For full legal power & more
- Puts power in antenna
- Broadbanded 3-40Mhz.
- Small, light, weather-proof
- 1:1 impedance ratio
- Replaces center insulator
- Helps eliminate TVI
- Fully Guaranteed

Van
go
der
Engineering
Box 21305, S. Euclid, OH 44121

Repeater Jammers Running You Ragged?
Here's a portable direction finder
that REALLY works—on AM,
FM, pulsed signals and random
noise! Unique left-right DF
allows you to take accurate (up
to 2") and fast bearings, even on
short bursts. Its 3dB antenna
gain and .006 pV typical DF sen-
sitivity allow this crystal-
controlled unit to hear and posi-
tively track a weak signal at very
long ranges—while the built-in
RF gain control with 120 dB
range permits positive DF to
within a few feet of the transmis-
ter. It has no 180° ambiguity
and the antenna can be rotated
for horizontal polarization.
The DF is battery-powered, can be used with accessory antennas, and is 12/24V for
use in vehicles or aircraft. It is available in the 140-150 MHz VHF band and/or
220-230 MHz UHF band. This DF has been successful in locating malicious inte-
ference sources, as well as hidden transmitters in "T-hunts", ELTs, and noise sources
in RFI situations.

Price for the single band unit is $170, for the VHF/UHF dual band unit is $205, plus
crystals. Write or call for information and free brochure.

L-TRONICS
5546 Cathedral Oaks Road
(Assignment Ham Dept.)
Santa Barbara, CA 93111

W6GUX
WD6ESW

Van Gorden
Engineering
You're just a few digits away from name brand radio equipment - AT DISCOUNT PRICES!

CALL TOLL FREE

1-800-228-4097
Communications Center
443 N. 48th Street
Lincoln, Nebraska 68504
In Nebraska Call (402) 466-8402

1-800-634-6227
Communications Center West
1072 N. Rancho Drive
Las Vegas, Nevada 89106
In Nevada Call (702) 647-3114

We carry all major lines of Antennas at Discount Prices

OUR NEW HOURS
at Lincoln store only

SAME DAY SHIPPING ON MOST ITEMS

1-800-228-4097
Communications Center
443 N. 48th, Lincoln, Nebraska 68504
In Nebraska Call (402) 466-8402

January 1979
CRYSTAL FILTERS and DISCRIMINATORS

9.0 MHz FILTERS

**XF9-A**
- 2.5 kHz SSB TX
- $40.65

**XF9-B**
- 2.4 kHz SSB RX/TX
- $55.10

**XF9-C**
- 3.75 kHz AM
- $59.30

**XF9-D**
- 5.0 kHz AM
- $59.30

**XF9-E**
- 12.0 kHz NBFM
- $59.30

**XF9-M**
- 0.5 kHz CW (4 pole)
- $41.50

**XF9-NB**
- 0.5 kHz CW (8 pole)
- $73.45

9.0 MHz CRYSTALS (HC~25/u)

**XF900**
- 9000.0 kHz Carrier
- $4.75

**XF901**
- 8998.5 kHz USB
- $4.75

**XF902**
- 9001.5 kHz LSB
- $4.75

**XF903**
- 8999.0 kHz BFO
- $4.75

**XF904**
- Hc25/u Socket Chassis
- $.50

**XF905**
- Hc25/u Socket P.C. Board
- $.50

VHF and UHF FILTERS

**PSf145**
- 145 MHz PS from Your Receiver
- $54.95

**PSf432**
- 432 MHz PS for your Transmitter
- $43.95

**PSf1296**
- 1296 MHz PS for your Transmitter
- $43.95

**PSf1691**
- 1691 MHz PS from your receiver
- $45.95

RECEIVE CONVERTERS

**MMf200-5**
- 30 db min. atten.
- $29.95

**MMf200-7**
- 40 db min. atten.
- $39.95

ANTENNAS (FOB CONCORD, VIA UPS)

**144-148 MHz J-SLOTS**
- $40.45

**MULTIBEAMS**
- $52.45

**48 EL**
- GAIN - 15.7 dBd
- $54.95

**88 EL**
- GAIN - 13.5 dBd
- $79.95

**UHF LOOP YAGIS**
- $56.95

**26 LOOPS**
- GAIN - 20.6 dBd
- $56.95

**1250-1340 MHz**
- $56.95

**1650-1750 MHz**
- $56.95

Send 30¢ (2 stamps) for full details of KVG crystal products and all your VHF & UHF equipment requirements.

Pre-Selector Filters
- $56.95

Varactor Triplers
- Crystal Filters

Varactor Diodes
- Frequency Meters

Antennas
- Oscillator Crystals

Spectrum International, Inc.
Post Office Box 1084
Concord, Mass. 01742, USA
fleamarket

RATES Non-commercial ads 10¢ per word; commercial ads 60¢ per word payable in advance. No cash discounts or agency commissions allowed.

HAMFESTS Sponsored by non-profit organizations receive one free Flea Market ad (front to our editorial). Repeat insertions of hamfest ads pay the non-commercial rate.

COPY No special layout or arrangements available. Material should be typewritten or clearly printed (not all capitals) and must include full name and address. We reserve the right to reject unsuitable copy. Ham Radio cannot check each advertiser and thus cannot be held responsible for claims made. Liability for correctness of material limited to corrected ad in next available issue.

DEADLINE 15th of second preceding month.

SEND MATERIAL TO: Flea Market, Ham Radio, Greeneville, N.H. 03048.

MICROWAVE POWER METER. Serry 66A1, similar to Hewlett-Packard 4318B. Good operating condition, $75.00. Gary Giehler, 22252, 241-20 Northern Blvd., Douglaston, N.Y. 11363 (212) 423-1906 evenings.

CANADIANS: 1,000,000 surplus electronic parts. Hundreds of fantastic bargains! Good deals on Yaesu & Icom. Free catalog, ETCO-1HR, 1630 Hymus Blvd., Pointe Claire, Quebec H9R 1E9.

FREQUENCY ALLOCATION CHART. See how the entire radio spectrum is used. 2 kHz to 200 GHz. Send $3.00 Collins Chart Co., Box 935, Coronado, CA 92118.

PORTA PAK the accessory that makes your mobile really portable. $67.50 and $86.00. Dealer inquiries invited. P.O. Box 67, P.O. Lemons, Wis. 53171.

SOLAR PANELS: 10 x 20 inches on 118-inch fiberglass, $90 ea. J. Zubrecky, PO Box 54220, Plattsburgh, N.Y. 12901.

MOBILE IGNITION SHIELDING provides more range with no noise. Available most engines. Many other suppression accessories. Literature, Estes Engineering, 930 Mars Dr., Port Angeles, WA 98362.

FOR SALE OR TRADE Excellent Kenwood TS200 transceiver and MCM1000 and 3070 with Atlas ac supply. Good condition. $185; 2m Handhelds: Wilson Mark II $205; Mark IV $229; Tempo S1 write. MFJ 15% off list. A&A Autodialer $78. Hustler antennas, Telex headsets, Taylor antennas in stock. Tower specials: Write for flyer. EGE, 2410 Drexel, Woodbridge, VA 22192 (703) 494-7949.

MOTOROLA HT200, HT300, and Pageboy service and modifications performed at reasonable rates. WA4FVR (804) 320-4438, evenings.

S133 GOOD COND. $275.00 — W6RGQ 1320 Curtis, Berkeley, CA 94702.


DEADLINE 15th of second preceding month.

SEND MATERIAL TO: Flea Market, Ham Radio, Greeneville, N.H. 03048.

THE MEASUREMENT SHOP has used/reconditioned test equipment at sensible prices; catalog 2 West 22nd St., Baltimore, MD 21218.
SEI
2m Linear Amplifiers & Regulated Power Supplies

SPA-100 Combination 75w 2m Linear Amplifier and 14A Power Supply. Use as a self-contained, 110V Base or separate 14A AC supply.
AMPLIFIER SECTION: For 2m FM or SS: All Solid State, Strip Line construction. 15w input, 70-80w output, 9w maximum drive FM, 20w PEP SS. 100% Duty Cycle. VSWR protected. No Tuning.
POWER SUPPLY SECTION: Adjustable, 3-14VDC, 1A continuous, 14A limit. Voltage and current meters. Overvoltage and short protected.
SPA-100 (5-15w input) $299.00
SPA-101 (15w input) $329.00

SMA-100 2m Mobile Linear Amplifier. 13.6VDC. Solid State, Strip Line construction. FM or SS.
5-15w input. 75-90w output. 25w maximum drive FM, 20w PEP SS. 100% Duty cycle. VSWR protected. No tuning. LED indicator. 4" x 9" x 9".
SMA-100 (5-15w input) $149.00
SMA-101 (15w input) $179.00

---

CLUB CALL PINS: 3 lines 1/4" x 3/4" $1.50 each. Call, first name and club. Colors - black, blue or red with white letters. (Catalog) Arnold Linzner, 2041 Linden Street, Ridgewood, N.Y. 11227.

AUTHORIZED DISTRIBUTOR F9FT Antennas, Microwave Modules. RW Products' new tandem reflector, 19 element, 432 MHz Yagi - Radio Clinic - N2MB (formerly WAZBT) 212-327-4952.

MICROWAVE low-noise TWT preamplifiers for satellite/satellite bands; 2-4.0 GHz passband; 25-30 dB gain; 110 volt 60 Hz power. TNC connectors; used units tested okay but sold as-is. $200 plus $4 shipping. M. Mursek, 5511 West Jerelyn, Milwaukee WI 53219.

TEST EQUIPMENT CATALOG listing used Tektronix, HP and GR equipment at bargain prices. PTL, Box 8699, White Bear Lake, MN 55110. Price $1.00 refundable with first order.


BILD DER WISSENSCHAFT Swap or sell. Have all copies from number one to present of this fantastic German scientific magazine. All in exemplary condition.
Sengel, 8181 Turin Road, Rome, N.Y. 13440.

STOP LOOKING for a good deal on amateur radio equipment - you've found it here - at your amateur radio headquarters in the heart of the Midwest. We may not have a toll free number but we'll save you more in the long run! We are factory-authorized dealers for Kenwood, Drake, Yaesu, Collins, Wilson, Ten-Tec, Atasila, ICOM, DenTron, MFJ, Tempo, Regency, Hy-Gain, Mostley, Alpha, CushCraft, Swan, and many more. Write or call us today for low price quote and our personal and friendly Hoosier service. HOOSIER ELECTRONICS, P.O. Box 2001, Terre Haute, Indiana 47802. (812) 238-1456.

COLLINS KWS1 $600: Hallicrafters SX101A, $100, excellent condition, W6ULZ (213) 347-3098.

BUY-SELL-TRADE: Send $1.00 for catalog. Give name, address and call letters. Complete stock of major brands, new and reconditioned amateur radio equipment. Call for best deals. We buy Collins, Drake, Swan, etc., Associates, 8012 Conover, Overland Park, KS 66204 (913) 381-5900.

WANTED - Radio transmission discs. Any size or speed. Larry, W7FZ, Box 724, Redmond, Washington 98052.

TUNSTEN CARBIDE CIRCUIT BOARD DRILLS. 12 assorted sizes for $3.95. P.O. Box 873, McMinnville, OR 97128.

ELECTRONIC EQUIPMENT HOTLINE is a classified advertising newsletter for professional, industrial, and surplus electronic equipment. Subscriptions $6/year, acts 50¢/word. P.O. Box 4783, Dept H4, Panorama City, CA 91412.


FREE CATALOGS: P.O. boards from your artwork or favorite magazine. Also parts and kits. Hauck Electronics, 1928 Fairacres Ave., Pgh., PA 15216.

DESK TOP CONSOLES, ultimate operating convenience. Free brochure. Thompson Electronics, P.O. Box 363, Westfield, IN 46074.

LAB TEST EQUIPMENT. Bargain prices. SAS for flyer. TDL Electronics, Box 9674, Kansas City, MO 64134.

HEWLETT PACKARD 10 to 525 MHz, 9645AM/AF signal generator - 10 to 525 MHz, 7055B/4056A frequency counter with battery pack - Motorola S-1233A deviation meter. All manuals. Sell as package - $500 value, all like new - asking $400. Robert Walter (216) 635-0949. 1625 Dover Center Rd., Westlake, Ohio 44145.

$800 HEATH All Mode Receiver. Mint with matching speaker $250.00. F. P. Pursell, 22 Fairlane Harbor, Vero Beach, FL 32960, (305) 569-0917.

RTTY - NS-1A PLL Demodulator W1T $26.95; kit $19.95; board only $4.95. Bandpass active filter 2125/2295 Hz; kit $11.95, WIT $16.95. All postpaid. SASE for info. Natl Sinnette Electronics, Tavares, FL 32778.


DRAKE TR-1 STATION, mint, acc. dc, $400 Paul Wallis, Box 322, Guerneville, California 95440 (707) 869-0578.

---

GERMAN DEALER
I'm looking for a wholesaler or manufacturer of transceivers and of all other accessories for Amateur Radio and CB.

If you are interested in direct export to Germany, please send us your proposal.

I am also interested in taking charge of an outlet, for example a dealership carrying your items, if possible with your participation.

Amateur- und CB-Funk
Odenbener Str. 56, P.O.B. 2226
0 7080 Offenburg, West Germany
Karl Rauchaufs, DF U 9

Presenting
THE A.R.O. UNITY RING
Your Prestige
Your Pride
The unique, one of a kind, personalized "A.R.O. UNITY RING". Your call letters. Your identity. Made just for you.

Group I/II. W2LBC, W2LBC and W2LBC designed this beautiful 15 carat Gold ring because of our pride in Amateur Radio. Wear this ring of distinction, personalized with your call letters and symbols of the great and proud fraternity of Amateur Radio. We invite you to QSL for full color brochure and free reusable ring size.

Boblehead Orders. Group III Sales Co.
Dept. 35 - P.O. Box 259
Little Neck, NY. 11362

102 january 1979
More Details? CHECK -- Off Page 118
**GREAT LAKES AMATEUR SUPPLY COMPANY**

**SPACE PROBLEMS?**

JUST LOOK AT WHAT YOU GET!
- LOW SWR < 1.1 AT BAND EDGES
- LIGHTWEIGHT: ONLY 15 POUNDS
- QUICK, EASY ASSEMBLY
- 50 OHM COAX FEED, ANY LENGTH
- TAKES 1 KW RF
- COVERS 10, 15, 20 & 40 METER BANDS (75 CAN BE ADDED)
- ONLY 21.5" LONG
- 1/4" HEAVY WALL ALUMINUM
- GROUND OR ROOF MOUNT
- STAINLESS STEEL HARDWARE
- RUGGED MOUNTING BRACKET
- SLIM, TRIM, GOOD LOOKING
- WORKS AS GOOD AS IT LOOKS

Call or write for your best deal on this and other fine HUSTLER antenna products.

**Tom Reed, W3WB**

**NEW NOTE ADDRESS**

1663 SIXTH STREET
MUSKEGON, MI 49441

(616) 722-2415

**R-853/URR AM-FM BROADCAST RECEIVER**

**Made by Jetronic. Slide-Rule tuning; 6" x 9" Speaker. And nine tubes. Walnut-Finished pressboard construction; 115 VAC 60 Hz or 220 VDC. 12 1/2 x 6 x 8" Sh. Wt. 15 lbs. Used, Reparable… $19.95**

**SPECIAL! 1978 ARRL Radio Amateur’s Handbook… $4.50**

All Prices F.O.B. Lima, Ohio. Please Allow for Shipping. Use your VISA or Mastercharge cards. Write for our big 36 page catalog.

**FAIR RADIO SALES**

1016 E. EURKA • Box 1105 • LIMA, OHIO • 45802
**SST T-1**  
**RANDOM WIRE ANTENNA TUNER**  
All band operation (160-10 meters) with any random length of wire. 200 watt output power capability—will work with virtually any transceiver. Ideal for portable or home operation. Great for apartments and hotel rooms—simply run a wire inside, out a window, or anywhere available. Efficient toroid inductor for small size: 4-1/4" x 2-3/8" x 3", and negligible loss. Built-in neon tune-up indicator. SO-239 connector. Attractive bronze finished enclosure.  
only **$29.95**

---

**SST T-2 ULTRA TUNER**  
Tunes out SWR on any coax fed antenna as well as random wires. Works great on all bands (80-10 meters) with any transceiver running up to 200 watts power output.  
Increases usable bandwidth of any antenna. Tunes out SWR on mobile whips from inside your car.  
Uses efficient tapped inductor and specially made capacitors for small size: 5-1/4" x 2-1/4" x 2-1/2". Rugged, yet compact. Negligible line loss. Attractive bronze finished enclosure. SO-239 coax connectors are used for transmitter input and coax fed antennas. Convenient binding posts are provided for random wire and ground connections.  
only **$39.95**

---

**SST T-3**  
**Mobile Impedance Transformer**  
Matches 52 ohm coax to the lower impedance of a mobile whip or vertical. 12-position switch with taps between 3 and 52 ohms. Broadband from 1.30 MHz. Will work with virtually any transceiver—300 watt output power capability. SO-239 connectors. Toroid inductor for small size: 2-3/4" x 2" x 2-1/4". Attractive bronze finish.  
only **$19.95**

---

**SST T-4 ULTRA TUNER DELUXE**  
Matches any coax fed antenna or random wire. Works with any transceiver. Great for mobile, portable, or home operation. Antenna switch selects between two coax fed antennas, random wire, or tuner bypass. Attractive bronze finished enclosure with exclusive SST Styling. Compact size: 9" x 2-1/2" x 5".  
Features:  
- 300 watts output capability.  
- All bands—1.8-30 MHz.  
- SWR meter built in.  
- Antenna switch on back panel.  
- Efficient tapped inductor.  
- 208 pf 1000 v. capacitors for flexible, reliable operation.  
NEW  
only **$69.95**

---

**GUARANTEE**  
All SST products are guaranteed for 1 year. In addition, they may be returned within 10 days for a full refund (less shipping) if you are not satisfied for any reason. Please add $2 for shipping and handling. Calif. residents, please add sales tax. COD orders OK by phone.

---

**ELECTRONICS**  
P.O. BOX 1  LAWNDALE, CALIF.  
90260  (213) 376-5887

---

More Details? CHECK—OFF Page 118  
**january 1979**
The Popular
CUA 64-12
by Heights

Light, permanently beautiful ALUMINUM towers

THE MOST IMPORTANT FEATURE OF YOUR ANTENNA IS PUTTING IT UP WHERE IT CAN DO WHAT YOU EXPECT. RELIABLE DX — SIGNALS EARLIEST IN AND LAST OUT.

ALUMINUM
Complete Telescoping and Fold-Over Series Available
Self-Supporting
Easy to Assemble and Erect
All towers mounted on hinged bases

And now, with motorized options, you can crank it up or down, or fold it over, from the operating position in the house.

Write for 12 page brochure giving dozens of combinations of height, weight and wind load.

Please include 30c (stamps or coins) for postage and handling when requesting our free literature.

ALSO TOWERS FOR WINDMILLS

HEIGHTS MANUFACTURING CO.
In Almont Heights Industrial Park
Almont, Michigan 48003

NEW... CoaxProbe*... NEW
Coaxial RF Probe for Frequency Counters and Oscilloscopes That Lets You Monitor Your Transmitted Signal Directly From the Coax Line.

$12.95
Only $12.95 plus $.50 postage

FINALLY! A RF PROBE that lets you connect into your coax cable for frequency measurements and modulation waveform checks directly from the transmitter.

JUST CONNECT THE CoaxProbe* into your transmission line and plug the output into the frequency counter or oscilloscope. Insertion loss is less than .2db so you can leave it in while you operate.

A NECESSITY IN ANY WELL-ORGANIZED HAM SHACK, the CoaxProbe* eliminates "jerky-rigging" and hassles when tapping into the coax line is desired.

A SPECIAL METHOD OF SAMPLING keeps output relatively constant with a wide variation of power. Power output of 8 watts gives .31v out, while 800 watts will give 1.8v out. (rms 3-30 mhz.) 2000 watts PEP rating too!

*Trademark of CoaxProbe Co. for rf sampling device.
© 1978 by CoaxProbe Co.

TEST EQUIPMENT
All equipment listed is operational and unconditionally guaranteed. Money back if not satisfied. Prices listed are F.O.B. Monroe.
Boonton 190A Q meter 20 260MHz
Q $ 1200
GR106A Stand sig gen 5k Hz
GR106A Stand sig gen 5k Hz
50MHz calib attn.................. 255
HP170A (USM140) 30MHz scope with
Hp170A (USM140) 30MHz scope with
reg horiz, dual trace vert plugs 475
Tek565 Dual beam 10MHz scope
Tek565 Dual beam 10MHz scope
less plug ins (3 series)........... 625
HPI90A Stand sig gen 10kHz 50MHz
HPI90A Stand sig gen 10kHz 50MHz
calib attn.................. 225
Weinschel 70 Prec RF-attn DC
Weinschel 70 Prec RF-attn DC
15Hz 0 40kHz, 10dB steps 8w...
15Hz 0 40kHz, 10dB steps 8w...
625

GRAY Electronics
P.O. Box 941, Monroe, Mich. 48161
Specializing in used test equipment.

USE IT ON 2 METER RIGS TO ADJUST FREQUENCY. The CoaxProbe* has a range of 1.8 to 150 mhz.

MONITOR YOUR MODULATION WAVEFORM. With an oscilloscope of proper bandwidth, you can check your modulation for flat-topping, etc. Ideal for adjusting the speech processor.

NOW YOU CAN MONITOR SIGNALS when connected to the dummy load, eliminating unnecessary on-the-air radiation.

AVAILABLE FOR THE FIRST TIME TO AMATEURS. Try it for 10 days. If not satisfied, send it back for refund (minus shipping charges).

Order today from:
CoaxProbe Co.
P.O. Box 426, Portage, MI 49081
Michigan Res. Add 4% Sales Tax

SYNTHESIZERS
We have the worlds largest selection of synthesizers for receivers, transmitters and transceivers. For complete details see our 1/3 page ad in the April 1976 issue of this magazine or call or write for additional information. Phone orders accepted between 9 AM and 4 PM EDT. (212) 468-2720

VANGUARD LABS
196-23 JAMAICA AVENUE
HOLLIS, N. Y. 11423

ANTENNA BALUN KIT
ONE KWAT

DIPOLES WINDOMS
BEAMS VEE QUADS

Still only $5
ADD 75¢ FOR POSTAGE & HANDLING
Ask for free 'Data-Flyer' on Ferromagnetic Materials

AMIDON ASSOCIATES
12033 OTSEGO STREET, NORTH HOLLYWOOD. CALIF. 91607
### DIODES/ZENERS
<table>
<thead>
<tr>
<th>(N)</th>
<th>Description</th>
<th>Value</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1N914</td>
<td>100v 10mA</td>
<td>.05</td>
<td></td>
</tr>
<tr>
<td>1N4005</td>
<td>600v 1A</td>
<td>.08</td>
<td></td>
</tr>
<tr>
<td>1N4007</td>
<td>1000v 1A</td>
<td>.15</td>
<td></td>
</tr>
<tr>
<td>1N4148</td>
<td>75v 10mA</td>
<td>.05</td>
<td></td>
</tr>
<tr>
<td>1N4733</td>
<td>5.1v 1W Zener</td>
<td>.25</td>
<td></td>
</tr>
<tr>
<td>1N753A</td>
<td>6.2v 500mW Zener</td>
<td>.25</td>
<td></td>
</tr>
<tr>
<td>1N758A</td>
<td>10v</td>
<td>.26</td>
<td></td>
</tr>
<tr>
<td>1N759A</td>
<td>12v</td>
<td>.26</td>
<td></td>
</tr>
<tr>
<td>1N5243</td>
<td>13v</td>
<td>.25</td>
<td></td>
</tr>
<tr>
<td>1N5244B</td>
<td>14v</td>
<td>.25</td>
<td></td>
</tr>
<tr>
<td>1N5245B</td>
<td>15v</td>
<td>.25</td>
<td></td>
</tr>
</tbody>
</table>

### SOCKETS/BRIDGES
- **8-pin pcb**
- **20**
- **ww**
- **.35**
- **14-pin pcb**
- **30**
- **ww**
- **.40**
- **16-pin pcb**
- **20**
- **ww**
- **.40**
- **18-pin pcb**
- **35**
- **ww**
- **.75**
- **22-pin pcb**
- **35**
- **ww**
- **.95**
- **24-pin pcb**
- **35**
- **ww**
- **1.25**
- **28-pin**
- **200**
- **ppr**
- **.95**

### TRANSISTORS, LEDS, etc.
<table>
<thead>
<tr>
<th>(N)</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>2N2222</td>
<td>NPN (2N2222 Plastic)</td>
<td>.15</td>
</tr>
<tr>
<td>2N2907</td>
<td>PNP</td>
<td>.15</td>
</tr>
<tr>
<td>2N3906</td>
<td>PNP (Plastic - Unmarked)</td>
<td>.10</td>
</tr>
<tr>
<td>2N3904</td>
<td>PNP (Plastic - Unmarked)</td>
<td>.10</td>
</tr>
<tr>
<td>2N3504</td>
<td>NPN</td>
<td>.15</td>
</tr>
<tr>
<td>2N3055</td>
<td>NPN 15A</td>
<td>.05</td>
</tr>
<tr>
<td>2N3912</td>
<td>PNP Darlington</td>
<td>.95</td>
</tr>
<tr>
<td>LM324</td>
<td>Green, Red, Yellow</td>
<td>.15</td>
</tr>
<tr>
<td>D.L.747</td>
<td>7seg 5/8&quot; High com-anode</td>
<td>1.95</td>
</tr>
<tr>
<td>MAN72</td>
<td>7seg com-anode (Red)</td>
<td>1.25</td>
</tr>
<tr>
<td>MAN3610</td>
<td>7seg com-anode (Orange)</td>
<td>1.25</td>
</tr>
<tr>
<td>MAN82A</td>
<td>7seg com-anode (Yellow)</td>
<td>1.25</td>
</tr>
<tr>
<td>MAN74A</td>
<td>seg com-cathode (Red)</td>
<td>1.50</td>
</tr>
<tr>
<td>FN3509</td>
<td>seg com-cathode (Red)</td>
<td>1.25</td>
</tr>
</tbody>
</table>

### C MOS
<table>
<thead>
<tr>
<th>(N)</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>2800</td>
<td></td>
<td>.75</td>
</tr>
<tr>
<td>2801</td>
<td></td>
<td>.75</td>
</tr>
<tr>
<td>2802</td>
<td></td>
<td>.75</td>
</tr>
<tr>
<td>2803</td>
<td></td>
<td>.75</td>
</tr>
<tr>
<td>2804</td>
<td></td>
<td>.75</td>
</tr>
<tr>
<td>2805</td>
<td></td>
<td>.75</td>
</tr>
<tr>
<td>2806</td>
<td></td>
<td>.75</td>
</tr>
<tr>
<td>2807</td>
<td></td>
<td>.75</td>
</tr>
<tr>
<td>2808</td>
<td></td>
<td>.75</td>
</tr>
<tr>
<td>2809</td>
<td></td>
<td>.75</td>
</tr>
<tr>
<td>2810</td>
<td></td>
<td>.75</td>
</tr>
<tr>
<td>2811</td>
<td></td>
<td>.75</td>
</tr>
<tr>
<td>2812</td>
<td></td>
<td>.75</td>
</tr>
<tr>
<td>2813</td>
<td></td>
<td>.75</td>
</tr>
<tr>
<td>2814</td>
<td></td>
<td>.75</td>
</tr>
</tbody>
</table>

### INTEGRATED CIRCUITS UNLIMITED

8789 Clairemont Mesa Boulevard, San Diego, California 92111
(714) 278-4394 (Calif. Res.)

All orders shipped prepaid
No minimum
Open accounts invited
COD orders accepted

Discounts available at OEM Quantities
California Residents add 6% Sales Tax
All IC's Prime/Guaranteed. All orders shipped same day received.

24 Hour Toll Free Phone 1-800-854-2211
American Express / BankAmericard / Visa / MasterCard
RTTY for ALL Systems

**MODEL 400**

**ELECTROCOM® "SERIES 400" FREQUENCY SHIFT CONVERTERS**

Professionally engineered for outstanding performance, stability, and reliability, the Electrocom® Models 400 and 402 add new dimensions of compatibility between radio and teletypewriter systems. Manufactured to highest quality standards—an Electrocom tradition for nearly two decades—these units are ideal for military, government, commercial, civil defense and amateur applications. The Model 400 front panel digital knob accurately selects shifts up to 1000 Hz, while two such knobs on the Model 402 independently set the mark and space frequencies. Both models may also be preset with any tone pair between 1000 and 3200 Hz.

Optimum performance with FSK or AFSK systems is assured by matched filters, precision linear detectors, baud rate selector, bias compensation, and semi-diversity circuitry. Operation is enhanced by a CRT monitor, autostart with solid-state motor switching, antispace, markhold, EIA/MIL output voltages, and a constant current loop supply. In addition, various options are available including rack mounting and polar current output.

Write or call us for complete product details and specifications. Learn why Electrocom® "400" Converters are designed not only for today's communication environment, but ultimately to fulfill RTTY requirements for years to come.

---

**NEW! 600 MHz Mini Counter**

**DAVIS ELECTRONICS 636 Sheridan Dr., Tonawanda, NY 14150 716-874-5648**

**Pre-Amp PROBE 10-500 MHz**

**Only $49.95**

**NEW!**

**TUBES FOR YAESU RIGS**

These excellent Japanese-made Fox-Tango brand tubes match Yaesu rigs so perfectly that neutralization adjustment is rarely required. Our tubes are noted for their high output and long life. Quantities limited. Get a selected set while they last. Satisfaction guaranteed.

*Marlin P. Jones & Associates, PO Box 9023 Riviera Beach, Florida 33404 (305) 848-8226

**MPJ**

*Fla. residents add 4% sales tax.**

**3% VISA accepted, please include expiration date and signature as on card.

Add $1.00 for order under $10.00.

**Canada and foreign orders please add sufficient postage.**

**USA orders please add 5% postage.**

**SET A**

2-6UC6C's $25

1-12BY7A 1-2101/277 series

**SET B**

2-6KD6C's $30

1-6G6KA 45-2400, 560, 570

FT ACCESSORIES

DIVISION OF FOX TANGO CORPORATION

**BOX 274, BRONX, N. Y. 10463**
Many of our best engineers read this magazine every month.

That's because a lot of our engineers at GE Mobile Radio are amateur operators—just like you. And that's why we're in this magazine—looking for more "hams" who'd like to put their engineering know-how to work on our equipment.

We're involved in the total spectrum of land mobile communications technology—including small signal and power RF circuits, custom monolithic ICs, thick-film hybrid circuit design and process technology, frequency synthesis and the application of microprocessors to land mobile communications, to name a few.

We have openings for EEs with experience in RF hardware design and in control/signaling hardware and software...and for MEs with a background in electronic product packaging. The best candidates will also be self-starters who can hold their own in a technical discussion. Engineers who enjoy designing communication equipment and can separate their hamming interest from their professional work.

We have top-notch lab facilities, interesting assignments, and some of the best people in the business. We can also provide choice living in progressive Lynchburg (just the right size at 70,000), or among Virginia's beautiful rolling hills where there's plenty of room for your own "antenna farm."

Want more details? Send your resume along with salary requirements to: Professional Relations, Dept. 98-N, General Electric, Mountain View Road, Lynchburg, Va. 24502.
Ham Radio's guide to help you find your local

Alaska

RELIABLE ELECTRONICS
3306 COPE STREET
ANCHORAGE, AK 99503
907-279-5100
Kenwood, Yaesu, DenTron, Wilson, Atlas, ICOM, Rohn, Tri-Ex.

Arizona

HAM SHACK
4506 A NORTH 16TH STREET
PHOENIX, AZ 85016
602-279-HAMS
Serving all amateurs from beginner to expert.

KRYDER ELECTRONICS
5520 NORTH 7TH AVENUE
NORTH 7TH AVE. SHOPPING CTR.
PHOENIX, AZ 85013
602-249-3739
Your Complete Amateur Radio Store.

POWER COMMUNICATIONS
6012 NORTH 27th AVE.
PHOENIX, AZ 85017
602-242-6030
Arizona's #1 Ham Store. Kenwood, Drake, ICOM & more.

California

HAM RADIO OUTLET
999 HOWARD AVENUE
BURLINGAME, CA 94010
415-342-5757
Visit our stores in Van Nuys and Anaheim.

QUEMENT ELECTRONICS
1000 SO. BASCOM AVENUE
SAN JOSE, CA 95128
408-998-5900
Serving the world's Radio Amateurs since 1933.

SHAWER RADIO
3550 LOCHINVAR AVE.
SANTA CLARA, CA 95051
408-247-4220
Atlas, Kenwood, Yaesu, KDK, Icom, Temp, Wilson, Ten-Tec.

Florida

AGL ELECTRONICS, INC.
1800-B DREW ST.
CLEARWATER, FL 33515
813-461-HAMS
West Coast's only full service Amateur Radio Store.

AMATEUR RADIO CENTER, INC.
2805 N.E. 2ND AVENUE
MIAMI, FL 33137
305-573-8383
The place for great dependable names in Ham Radio.

MARC'S CENTRAL EQUIPMENT CO., INC.
18451 W. DIXIE HIGHWAY
NORTH MIAMI BEACH, FL 33160
305-932-1818
See Marc, WD4AAS, for complete Amateur Sales & Service.

RAY'S AMATEUR RADIO
1590 US HIGHWAY 19 SO.
CLEARWATER, FL 337516
813-535-1416
West coast's only dealer: Drake, Icom, Cushcraft, Hustler.

Illinois

AUREUS ELECTRONICS, INC.
1415 N. EAGLE STREET
NAPERVILLE, IL 60540
312-420-8629
"Amateur Excellence"

ERICKSON COMMUNICATIONS, INC.
5456 N. MILWAUKEE AVE.
CHICAGO, IL 60630
312-631-5181
Hours: 9:30-9:00 Mon. & Thurs.; 9:30-5:30 Tu, Wed, Fri; 9:00-3:00 Sat.

SPECTRONICS, INC.
1009 VAREFIELD STREET
OAK PARK, IL 60304
312-848-6777
Chicagoland's Amateur Radio leader.

Indiana

KRYDER ELECTRONICS
GEORGETOWN NORTH SHOPPING CENTER
2810 MAPLECREST RD.
FORT WAYNE, IN 46815
219-484-4946
Your Complete Amateur Radio Store. 819 T, TH, F; 10-5 W, SAT.

Iowa

BOB SMITH ELECTRONICS
RFD #3, HIGHWAY 169 and 7 FT. DODGE, IA 50501
515-576-3886
For an EZ deal.

Kansas

ASSOCIATED RADIO
8012 CONSER P. O. B. 4327
OVERLAND PARK, KS 66204
913-381-5901
Amateur Radio's Top Dealer. Buy — Sell — Trade

Massachusetts

TEL-COM, INC.
675 GREAT RD. RT. 119
LITTLETON, MA 01460
617-486-3040
The Ham Store of New England you can rely on.

TUFTS RADIO ELECTRONICS
209 MYSTIC AVENUE
MEDFORD, MA 02155
617-395-8280
New England's friendliest ham store.

Michigan

ELECTRONIC DISTRIBUTORS
1960 PECK STREET
MUSKEGON, MI 49441
616-726-3196
Dealer for all major amateur radio product lines.

RADIO SUPPLY & ENGINEERING
1207 WEST 14 MILE ROAD
CLAWSON, MI 48017
313-435-5660
10001 Chalmers, Detroit, MI 48213, 313-371-9050.

Missouri

HAM RADIO CENTER, INC.
8340-42 OLIVE BLVD.
ST. LOUIS, MO 63132
800-325-3636
For Best Price and Fast Delivery Call toll free 1-800-325-3636

Dealers: YOU SHOULD BE HERE TOO!
Contact Ham Radio now for complete details.
Amateur Radio Dealers

Nebraska
COMMUNICATIONS CENTER, INC.
443 NORTH 48 ST.
LINCOLN, NE 68504
800-228-4097
Kenwood, Yaesu, Drake and more at discount prices.

New York
AM-COM ELECTRONICS INC.
RT. 5
NORTH UTICA SHOPPING CTR.
UTICA, NY 13502
315-732-3656
The Mohawk Valley's Newest & Largest Electronics Supermarket.

New Hampshire
EVANS RADIO, INC.
BOX 893, RT. 3A BOW JUNCTION
CONCORD, NH 03301
603-224-9961
Icom, DenTron & Yaesu dealer. We service what we sell.

New Jersey
ATKINSON & SMITH, INC.
17 LEWIS ST.
EATONTOWN, NJ 07724
201-542-2447
Ham supplies since “55”.

Nevada
COMMUNICATIONS CENTER WEST
1072 RANCHO DRIVE
LAS VEGAS, NV 89106
800-634-6227
Kenwood, Yaesu, Drake and more at discount prices.

Ohio
AMATEUR RADIO
SALES & SERVICE INC.
2187 E. LIVINGSTON AVE.
COLUMBUS, OH 43209
614-236-1625
Antennas for all services.

Oklahoma
RADIO STORE, INC.
2102 SOUTHWEST 59th ST.
(AT 59th & S. PENNSYLVANIA)
OKLAHOMA CITY, OK 73119
405-682-2929
New and used equipment — parts and supply.

Pennsylvania
ARTCO ELECTRONICS
302 WYOMING AVENUE
KINGSTON, PA 18704
717-288-8585
The largest variety of semiconductors in Northeastern Pennsylvania.

Tennessee
GERMANTOWN AMATEUR SUPPLY
3203 SUMMER AVE.
MEMPHIS, TN 38112
800-238-6168
No monkey business. Call Toll Free.

Texas
AGL ELECTRONICS
3068 FOREST LANE, SUITE 309
DALLAS, TX 75234
214-241-6414 (within Texas)
Out-of-State, Call our toll-free number 800-527-7418.

January 1979
our little boxes replace a lot of cable!

- select any of five antennas at the turn of a knob, with just one feedline and a control cable to the remote switching unit.
- saves coax, simplifies station layout.
- handles 4 kw p.e.p.
- other models to nine positions.
- full one-year warranty.

model sw-5 heavy duty
REMOTE CONTROLLED ANTENNA SWITCH — $135.00 plus $3 shipping
order direct or write for brochure.

ANTENNA MART
515-292-7114
box 1010, i.s.u. station, Ames, Iowa 50010

NEW - IMPROVED*
Model 1500 - Binaural Synthesizer-Filter with Tone-Tag
Uten 8 "D" Cells - Less Batteries $86.00 ppd. U.S.
Model 1501 - Requires your 12 to 15 volt D.C. input, 100 ma., nom. (internal regulation) $89.00 ppd. U.S.
Wall Transformer 115V AC supply rated at 25 volts, 350 ma., for use with Model 1501 or .... $4.95

* A new balanced bipolar Tone-Tag modulator system replaces diode modulators of Models 1100 and 700.

GET BETTER THAN 100HZ EFFECTIVE SELECTIVITY ON CW, A SELECTABLE NOISE BANDWIDTH OF LESS THAN 150 HZ PLUS PERIPHERAL HEARING IN BINAURAL SOUND... ALL WITHOUT LISTENING THROUGH THE TINKLING ROAR OF A NARROW-BAND FILTER OR FUSING WITH SELECTIVE SQUELCH SYSTEMS... EXPERIENCE THE BINAURAL FUNCTION ON SIDE BAND VOICE... Just connect to your receiver's headphone or speaker jack and plug in two 8 Ohm speakers arranged stereo fashion... additional jack provided at lower power to protect your stereo headsets.

See HR magazine articles on Nov., '75 and Nov., '76... Ask for our note on listening with binaural and Tone-Tag systems.

HILDERETH ENGINEERING BOX 60003 SUNNYVALLE CA 94088
Happy New Books

NEW 21st Edition RADIO HANDBOOK

by Bill Orr, W6SAI

Pre-publication special $19.50

1979 Foreign Callbook

If you're into DX, this year's new edition is a must. It's a vital reference when collecting those valuable QSL's. You'll have the very latest QST information plus all the other data that the Callbook is famous for like international postal information, Great Circle Bearings, Countries Lists, Time Charts and more.

Softbound $14.95

THE BASIC BOOK OF HAM RADIO

by Consumer Guide and ARRL

A practical, non-technical book for anyone with an interest in Amateur Radio. In easy to understand language, The Basic Book of Ham Radio tells how the Amateur Radio Service works, how to obtain a license, what to buy to get on the air, and where the action is — awards, contests, public service, satellite communications, radio clubs, and other ham activities. It also explains gear specifications, offers practical tips for the beginner, and discusses FCC rules and regulations. 129 pages. ©1976. Softbound $4.95

ORDER TOLL FREE 800-258-5353

ORDER FORM

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>24034</td>
<td>Radio Handbook</td>
<td>$19.50</td>
</tr>
<tr>
<td>AR-HB79</td>
<td>ARRL Radio Amateur’s Handbook</td>
<td>$9.75</td>
</tr>
<tr>
<td>CB-US</td>
<td>1979 US Callbook</td>
<td>$15.95</td>
</tr>
<tr>
<td>CB-F</td>
<td>1979 Foreign Callbook</td>
<td>$14.95</td>
</tr>
<tr>
<td>CG-HR</td>
<td>Basic Book of Ham Radio</td>
<td>$4.95</td>
</tr>
</tbody>
</table>

PAYMENT INFORMATION

☐ Check or money order enclosed
☐ VISA ☐ Master Charge

Account # __________________________ MC Bank # __________________________
Expires __________ Date: __________

SEND TO:

Name ____________________________ Address ____________________________
City ____________________________ State ______ Zip __________

Please include $1.00 shipping charge (plus $1.75 when ordering Callbook).

Ham Radio's Bookstore, Greenville, NH 03048
WANTED FOR CASH

RADIO SET CONTROL
C-3866/1RC

We stand on our long track record, offer to pay 5% more than any other bonafide offer.

See last month's ad for other items available.

618-T Transceiver
(Also known as MRC95, ARCC4, ARC102, or VC102)

DCO, INC.
10 Schuyler Avenue
No. Arlington, N.J. 07032

Evenings (201) 988-6475

HAVE BARRELS OF FUN ----
WITHOUT DRAINING YOU DRY !
WHY PAY FOR USELESS FRILLS ?
GET AN EXCELLENT BASIC DESIGNED REPEATER WITH
DEPENDABLE PERFORMANCE !
LET US HELP YOU WITH YOUR REPEATER PROJECT
COMPLETE AVAILABLE STOCK NOW FROM
"CREATIVE ELECTRONICS ."
AUTHORIZED DEALERS FOR : VHF ENGINEERING AND THEIR COMPLETE STOCK
ALSO AVAILABLE COMPLETE LINE IN HAMTRONICS, KACOM,
PHELPS DODGE AND NEW ACCESSORY ITEMS OF OUR OWN
FOR REPEATERS

CREATIVE ELECTRONICS
p.o. box 7054
marietta, georgia
30065

we accept

DIPOLE ANTENNA CONNECTOR

BUDWIG MFG. Co., P.O. box 974, Ramona, CA 92065

FREE CATALOG
HARD-TO-FIND PRECISION TOOLS
Largest line plus 3000 names, plus vacuums, wave
driers, vacuum systems, relay tools, optical
equipment, tool kits and cases. Also includes two
pages of useful "Tool Tips" to aid in tool selection.

JENSEN TOOLS & ALLOYS
an american precision tool corp.
35 Rutca Court, S. Hackensack, N.J. 07606

MILITARY SURPLUS WANTED
Space buys more and pays more. Hig- est prices ever on U.S. Military sur- plus, especially on Collins equipment or parts. We pay freight. Call collect now for our high offer. 201-440-8878

SPACE ELECTRONICS CO.
div of Military Electronics Corp.
35 Rutca Court, S. Hackensack, N.J. 07606

D & V RADIO PARTS
VARIABLE & TUNABLE CAPACITORS of CHOICE-
AIR WOUND CABLE-TUNED-FREE THRU- TUBULAR THINNERS-KNOWN-WIRE-COUPLED-
TRANSWAT\ COMPONENTS.
No minimum order-line cost shipping.
First class mail for complete flyer.
1200 N. BARR, FOREST, MICHIGAN 48021

Barry Electronics ... Your One Source

for Amateur Radio Gear

New TEMPO S-1 SYNCOM

TWO-METER TRANSCEIVER
POCKET-SIZED • FULLY SYNTHESIZED • HAND HELD

WE STOCK THESE FAMOUS NAME BRANDS

BARRY ELECTRONICS
512 BROADWAY
NEW YORK, N.Y. 10012

114 January 1979

More Details? CHECK - OFF Page 118
CUSHCRAFT IS THE VHF-UHF ANTENNA COMPANY.

Cushcraft precision engineered VHF/UHF Yagi beams have become the standard of comparison the world over for SSB and CW operation on 6 meters through 432 MHz. Built by skilled craftsmen from the best available materials, these beams represent that rare combination of high electrical performance, rugged construction, and durability.

A 11-12 Meter Yagi

Quadr Array

Cushcraft's Quad Arrays for 144, 220, and 432 MHz use four matched 11-element Cushcraft Yagis and are the ultimate in high performance Yagi arrays. These arrays have been carefully engineered for maximum forward gain, high front to back ratio, and broad frequency response. All antennas provide a low VSWR match to 50-ohm coaxial feedline.

20 Element DX Array

Cushcraft's wide variety of VHF/UHF Beams includes an antenna for every amateur activity above 50 MHz, whether local ragchewing or long-haul over-the-horizon DX. All models have been carefully optimized for maximum forward gain with high front to back ratio. Their heavy wall bright hard drawn aluminum booms and elements are combined with heavy formed aluminum brackets and plated mounting hardware for long operating life and survival in severe weather.

CAL CRYSTAL LAB, INC.
1142 N. Gilbert Street
Anaheim, CA 92801
(714) 991-1580

GEM QUAD PRODUCTS LTD.
Box 53
Transcona Manitoba
Canada R2C 2Z5
Tel. (204) 866-3338

GEM-QUAD FIBRE-GLASS ANTENNA FOR 10, 15, AND 20 METERS

Two Elements $139.00
Extra Elements $99.00
Price is F.O.B. Transcona
INCLUDES U.S. Customs Duty
KIT COMPLETE WITH
* SPIDER
* ARMS
* WIRE
* BALUN KIT
* BOOM WHERE NEEDED
WINNER OF MANITOBA DESIGN INSTITUTE AWARD OF EXCELLENCE

Buy two elements now—a third and fourth may be added later with little effort.

Enjoy up to 8 dB forward gain on DX, with a 25 dB back to front ratio and excellent side discrimination. Get maximum structural strength with low weight, using our "Tridetic" arms. Please inquire directly to:

GEM QUAD PRODUCTS LTD.
Box 53
Transcona Manitoba
Canada R2C 2Z5
Tel. (204) 866-3338

More Details? CHECK — OFF Page 118

QUARTZ CRYSTALS
"IN A HURRY"
SINCE 1970

CRYSTALS AVAILABLE FOR:
- CB - Synthesizers
- Amateur - HF, VHF, UHF
- Industrial
- Scanner
- Marine - LB & VHF
- Conversion Crystals
- Special Attention to R & D.
- *Micro-processor Types.

DISCOUNTS AVAILABLE TO DEALERS & MANUFACTURERS
CALL "BONNIE" FOR PRICES & DELIVERY
VISA & Master Charge credit cards accepted.

CAL CRYSTAL LAB, INC.
1142 N. Gilbert Street
Anaheim, CA 92801
(714) 991-1580

GEM QUAD PRODUCTS LTD.
Box 53
Transcona Manitoba
Canada R2C 2Z5
Tel. (204) 866-3338

GEM-QUAD FIBRE-GLASS ANTENNA FOR 10, 15, AND 20 METERS

Two Elements $139.00
Extra Elements $99.00
Price is F.O.B. Transcona
INCLUDES U.S. Customs Duty
KIT COMPLETE WITH
* SPIDER
* ARMS
* WIRE
* BALUN KIT
* BOOM WHERE NEEDED
WINNER OF MANITOBA DESIGN INSTITUTE AWARD OF EXCELLENCE

Buy two elements now—a third and fourth may be added later with little effort.

Enjoy up to 8 dB forward gain on DX, with a 25 dB back to front ratio and excellent side discrimination. Get maximum structural strength with low weight, using our "Tridetic" arms. Please inquire directly to:

GEM QUAD PRODUCTS LTD.
Box 53
Transcona Manitoba
Canada R2C 2Z5
Tel. (204) 866-3338

GEM QUAD PRODUCTS LTD.
Box 53
Transcona Manitoba
Canada R2C 2Z5
Tel. (204) 866-3338

GEM-QUAD FIBRE-GLASS ANTENNA FOR 10, 15, AND 20 METERS

Two Elements $139.00
Extra Elements $99.00
Price is F.O.B. Transcona
INCLUDES U.S. Customs Duty
KIT COMPLETE WITH
* SPIDER
* ARMS
* WIRE
* BALUN KIT
* BOOM WHERE NEEDED
WINNER OF MANITOBA DESIGN INSTITUTE AWARD OF EXCELLENCE

Buy two elements now—a third and fourth may be added later with little effort.

Enjoy up to 8 dB forward gain on DX, with a 25 dB back to front ratio and excellent side discrimination. Get maximum structural strength with low weight, using our "Tridetic" arms. Please inquire directly to:

GEM QUAD PRODUCTS LTD.
Box 53
Transcona Manitoba
Canada R2C 2Z5
Tel. (204) 866-3338

More Details? CHECK — OFF Page 118
RADIO AMATEUR CALLBOOKS

The U.S. Callbook has nearly 350,000 W & K listings. It lists calls, license classes, names and addresses plus the many valuable back-up charts and references you come to expect from the Callbook.

Specialize in DX? Then you're looking for the Foreign Callbook with almost 285,000 calls, names and addresses of amateurs outside of the USA.

U.S. Callbook $15.95
Foreign Callbook $14.95

(Plus Shipping)

Order from your favorite electronics dealer or direct from the publisher. All direct orders add $1.75 for shipping. Illinois residents add 5% Sales Tax.

RADIO AMATEUR CALLBOOK INC
Dept. E 925 Sherwood Drive
Lake Bluff, Ill. 60044

ALL BAND TRAP ANTENNAS!

PRETUNED - COMPLETELY ASSEMBLED - ONLY ONE NEAT SMALL ANTENNA FOR UP TO 6 BANDS! EXCELLENT FOR CONGESTED HOUSING AREAS - APARTMENTS - LIGHT - STRONG - ALMOST INVISIBLE!

COMPLETE AS SHOWN with 90 ft. RG58U-50 ohm feedline, and PL259 connector, insulators, 30 ft. 300 lb. test dummy in 5 sections, center connector with built-in lightning, amateur and static discharge - molded, sealed, weatherproof, resonant traps 750K - you just switch to band desired for excellent worldwide operation - transmitting and receiving WT. LESS THAN 5 LBS.

160-80-40-20-15-10 bands 2 trap-1/4 ft with 90 ft. RG58U - connector - Model 777U . . . $54.95
20-40-20-15-10 bands 2 trap --- 9 ft. with 90 ft. RG58U - connector - Model 999U . . . . $49.95
40-20-15-10 bands 2 trap --- 5 ft. with 90 ft. RG58U - connector - Model 1007BU . . . . . . $46.95
20-15-10 bands 2 trap --- 2-5 ft. with 90 ft. RG58U coax - connector - Model 1007BU . . . . $47.95

SEND FULL PRICE FOR POST PAID INSURED DEL IN USA. Canada is $5.00 extra
for postage - WIRE - CHARGE - AIR MAIL. For overseas or by phono please add an additional $5.00 for postage.

WESTERN ELECTRONICS
Dept. AR-1
Kearney, Nebraska, 68047

THE PERFECT COUPLE! - HMR'S REPEATER & CONTROLLER

HMR now offers a full line of repeaters for every band and commercial application. Customer acceptance and in field reliability has been so good that we now give a full two year warranty on all our amateur products. Write us and we will be glad to send you all the details.

HMR COMMUNICATIONS, INC., ARD, WEST NEWTON, PA 15089

MOVING?
KEEP HAM RADIO COMING...

If possible let us know four to six weeks before you move and we will make sure your HAM RADIO Magazine arrives on schedule. Just remove the mailing label from this magazine and affix below. Then complete your new address (or any other corrections) in the space provided and we'll take care of the rest.

Subscription Processing Center, P.O. Box 711
Whitinsville, MA 01588

Allow 4-6 weeks for correction.
Thanks for helping us to serve you better.

Here's my new address:
Name
Address
City
State Zip

AFFIX LABEL HERE
The complete receiver audio active filter
YOU CAN DO IT SIMULTANEOUSLY with both NOTCH and BANDPASS filters.

NOTCH FILTER
CONTINUOUSLY VARIABLE
100 - 1400 Hz.
NOTCH DEPTH FIXED AT NO LESS THAN 30 DB.
INDEPENDENT OF BANDPASS CONTROLS.
MAY BE CENTERED FROM 200 - 1400 Hz.

SL-55
Audio Active Filter
Both filters are cascaded with a fixed lowpass filter (18 db/octave rolloff above 1400 Hz) for optimum SSB filtering. (3.5x3.5x7.5 inches)

WARRANTY
ONE YEAR
FULLY PROOF

CONTAINS 115 VAC POWER SUPPLY, REQUIRES LOW IMPEDANCE (-15 OHM) AUDIO DRIVE FROM ANY RECEIVER. CONNECTS IN SERIES WITH AUDIO OUTPUT LINE AND WITH POWER SUPPLY HEADPHONES. AUDIO OUTPUT INDEPENDENT OF POWER WATTAGE. CHANNEL WIDTH CONTINUOUSLY VARIABLE FROM 1/4 TO MORE THAN 1400 Hz -- 3 DB.

NET: $72.50
Collins gray cabinet and dark gray wrinkle panel
postpaid in the USA and Canada Virginia resident add 4% sales tax

ERICA INTRODUCES A BRAND NEW CONCEPT IN THE MEASUREMENT OF VSWR AND POWER ACCEPTED BY THE LOAD

REQUIRES 115 VAC AT LESS THAN 1/16 AMP.
COOLLIS GRAY CABINET, WRINKLE PANEL -- BRIGHT RED LED DIGITS (.35"").
DEVIANCE POINT IS THE PILOT LIGHT.

SL-65A GREAT FOR QRP & CB

ELECTRONIC RESEARCH CORP. OF VIRGINIA
P. O. BOX 2394
VIRGINIA BEACH, VIRGINIA 23452
Advertizers

check-off

...for literature, in a hurry — we'll rush your name to the companies whose names you "check-off"

Place your check mark in the spaces between name and number. Ex: Ham Radio ✓ 234

INDEX

AED .... 710
Alume .... 589
Am. Elec. Supply .... 202
Amateur U.S.CF  Fork .... 93
Amidon .... 955
Amit .... 731
Anteck .... 733
Antenna Mart .... 709
Atlas .... 752
Barry .... 768
Budwig .... 323
Bullet .... 325
Cal Crystal .... 709
Clegg .... 207
d.com .... 756
Communications Center .... 534
Comm. Spec. .... 330
Creative Elec. .... 751
Crystal Banking ......
Curtai Electro .... 034
Cushcraft ....
DVF Radio .... 324
DSI .... 896
Darwin Comm. .... 561
Data Signal .... 270
Davis Elec. .... 322
Deake ....
E.T.O. ....
Electrocom .... 563
Elec. Research Virginia ....
Excel Circuits .... 635
FT Accessories .... 646
Fair Radio .... 048
Fong Tangio .... 667
GLB .... 552
GL Enterprises .... 573
G.E. ....
Gray .... 055
Great Lakes .... 732
Gregory ....
Group III .... 701
Gulf .... 625
Hai ....
HMR .... 735
Hai Trans .... 254
H. R. Magazine .... 150
H. R. P. G. .... 150
Hamtronics ....
Heath .... 960
Heights ....
Henry .... 062
Hirsh .... 263
Hy Gain .... 046
Iconic .... 056
Info Tech .... 351
Integ. Circuits .... 518
Int. Crystal .... 066
Jameco .... 333
Jan .... 067
Jensen .... 293
Jones .... 626
Kenwood ....
L. Towns .... 576
Long's .... 468
Lunar .... 577
Lyle .... 373
MFI .... 082
Madison ....
Milo .... 736
Oak Hill Academy ....
P.O. R. S. .... 640
Opportunity ....
Palomar Eng. ....
Callbook .... 100
Radio World .... 442
Raychem ....
S. F. A. R. S. .... 640
SST .... 375
Sabaltronics ....
Sarnoff .... 435
Space .... 223
Space .... 102
Spec. Comm. .... 366
Spec. Int. .... 108
Swell .... 111
TPL .... 240
Tee/Ax .... 485
Tektronix .... 377
Ten Tec ....
The Communications Center ....
Thomas Comm. .... 730
Tropical Hambone ....
V.H.F. Eng. .... 121
Van Gorden Eng. .... 737
Vanguard Labs .... 716
Vasion ....
Webster .... 423
Western .... 122
Whitehouse ....
Wilson .... 123
Yasu .... 127
Yasuk .... 092

*Please contact this advertiser directly.
Limit 15 inquiries per request.

January, 1979

Please use before February 28, 1979

Tear off and mail to
HAM RADIO MAGAZINE — "check-off"
Greenville, N. H. 03048

NAME  ..........................................

ADDRESS:  ..........................................

STREET  ..........................................

CITY  ..........................................

STATE  ..........................................

ZIP  .............................................

Terms: All prices for Houston. Prices subject to change without notice. All items guaranteed. Some items subject to prior sale. Send letterhead for amateur dealer's price list. Texas residents add 6% tax. Please add postage estimate.

MADISON ELECTRONICS SUPPLY, INC.

150B-D McKinney, Houston, Texas 77002

713/698-0268  NITES 713/497-5683

MADISON SUPER BOWL BUYS

Write in your best quote from the "800 gang.

Now, list the equipment you want in the spaces provided below, cut out this ad, and send it to us with your name, address and telephone number. We will write □ or call □ (check one) you back as soon as possible with the MADISON quote.

(Hint: Don't go below our cost.
We have an in-depth stock and large inventory of major lines and accessories.
You can buy a so-called "maximum legal power" linear for quite a bit less than the price of an ALPHA. What makes the ALPHA worth more . . . or the other model less?

TALK TO AN ALPHA OWNER — Notice how scarce used ALPHA's are? Owners are rarely willing to part with them, and will be delighted to tell you why.

CHECK ETO's TWO-YEAR (limited) WARRANTY — Others give you 90 days. But EIGHT TIMES as much protection is only part of the ALPHA warranty story; there's also a clear message about durability.

NO ALPHA 76/374/77D OWNER HAS EVER BURNED UP A POWER TRANSFORMER, despite our No Time Limit (NTL) full power key down rating. Maybe it's because our '76A transformer is nearly TWICE the size of those in competitive desk-top amplifiers and is cooled by ETO's full-cabinet, ducted-air system to boot.

LOOK INSIDE AN ALPHA — the difference in quality and ruggedness is conspicuous. Big coils . . . axial-flow ceramic triodes thoroughly cooled by a centrifugal blower . . . yet ETO's new acoustic-isolation blower system makes the ALPHA 76A series now even quieter than ever before.

EFFICIENCY, versatility, ease of operation, resale value — the story of ALPHA superiority goes on. Before you decide on a new linear, get all the details from your dealer or ETO direct. And ask for our free guide, "Everything You Always Wanted to Know About (Comparing) Linears . . . But Didn't Know Whom to Ask." Finally, do talk to an ALPHA owner . . . look for him on top of the nearest pile-up.
LONG'S CHOICES FOR CW ENTHUSIASTS.

1-800-633-3410

VIBROPLEX "The Original"
Can be slowed to 10 WPM or less or geared to a high rate of speed keeping high quality signal. Deluxe model—polished chrome w/jeweled movement & grey base. 59.95. 49.95 Standard. Call for yours today.

VIBROPLEX vibro-keyer
An electronic transmitting unit with large size contacts main frame, super finished parts, red finger and thumb pieces smooth trunion lever, adjustable. Deluxe finish 58.50. Standard finish 46.50 Call for yours today.

BENCHER Model BY-1 Iambic keyer paddle
Has adj. contact point spacing, wide tension adjustmen, self adjusting needle bearings, silver contact points, precision components, and a heavy black base, non skid feet. Model BY-2 polished chrome base 49.95. 39.95 Call for yours today.

HAM KEY HK-1
The HK-1 is a useful addition to any station. Base is cast iron with black finish. Dot and dash paddles have adjustable tension and spacing. Non-slip rubber feet prevent "walking". 29.95 Call for yours today.

NYE VIKING SSK-1-K keyer
Features: • Long, form-fitting paddles w/adj. spring tension and contact spacing • Extra-large gold plated silver contacts • Audio oscillator & speaker • Speed control • Polarity switch. 98.00 list price. Call for quote.

MFJ-720 Deluxe Super Filter
Has selectable band width, 8 pole active IC filter, sharp selectivity, auto noise limiter, plugs in phone jack, two watts for speaker, and 80 Hz BW, no ringing. 44.95 Call for yours today.

MFJ 721 Super selector CW/SSB filter
Has 80 Hz BW, steep SSB skirts, noise limiting, 2 watts for the speaker, select your bandwidth, and has an 8 pole active IC filter. 59.95 Call for yours today.

NYE VIKING 114-320-003 key
Key is constructed on a die-cast base. The hardware is nickel-plated. Has smooth adj. bearings and coin silver contacts. Black finished base, switch and Navy knob. 10.60 Call for yours today.

Long's Electronics

MAIL ORDERS: P.O. BOX 11347 BIRMINGHAM, AL 35202 • STREET ADDRESS: 2808 7TH AVENUE SOUTH BIRMINGHAM, ALABAMA 35233

Remember, you can Call Toll Free: 1-800-633-3410 in the U.S.A. or call 1-800-292-8668 in Alabama for our low price quote. Store hours: 9:00 AM til 5:30 PM, Monday thru Friday.
NEW ON 2 FROM YAESU

A compact versatile transceiver for the dedicated two-meter DXer, the optional memory and twenty-five watt output puts the FT-225RD far ahead. See it at your dealer’s today, or write for our full line catalog.

SPECIFICATIONS:

General
Frequency Range: 144-145 MHz, 145-146 MHz, 146-147 MHz, 147-148 MHz
Frequency Readout: Digital readout to 100 Hz, analog display resolution better than 1 KHz.
Modes of Operation: LSB, USB, CW, AM, FM
Frequency Stability: Within 100 Hz during any 30 minute period after warmup. Not more than 20 Hz with 10% line voltage variation.
Intermediate Frequencies: 1st IF = 10.7 MHz; 2nd IF = 455 KHz.
Antenna Impedance: 50 ohms unbalanced
Repeater Split: 600 KHz installed, any split up to 1 MHz with optional crystal.
Power Requirements: AC 100/110/117/200/234 Volts
DC 13.8 Volts, negative ground

Receiver
Sensitivity: SSB/CW 0.3 uV for 10dB S/N
FM 0.35 uV for 20dB QS
AM 1.0 uV for 10dB S/N
Selectivity: SSB/CW/AM 2.3 KHz at 6dB down
4.1 KHz at 60dB down
FM 12 KHz at 6dB down 28 KHz at 60dB down
Image Response: Better than —60dB
Spurious Response: Better than 1 uV at antenna

Power Consumption: AC Receive 30 VA
Transmit 160 VA at full output
DC Receive 1.2 Amps Transmit 6.5 Amps
Size: 280mm (W) × 125mm (H) × 315mm (D)
Weight: Approximately 9 kg

Price And Specifications Subject To Change Without Notice Or Obligation

YAESU ELECTRONICS CORP., 15954 Downey Ave., Paramount, CA 90723 • (213) 633-4007
YAESU ELECTRONICS Eastern Service Ctr., 9812 Princeton-Glendale Rd., Cincinnati, OH 45246
August 5, 1978

EIMAC 8973 tetrodes helped bring fusion power a step closer at Princeton.

Project PLT—a significant achievement

On August 5, 1978 scientists at Princeton University Plasma Physics Laboratory succeeded in heating a form of hydrogen to more than 60 million degrees Celsius and produced the highest temperature ever achieved in a TOKAMAK device—four times the temperature of the interior of the sun, thus bringing fusion power a step closer for mankind.

EIMAC tetrodes for switching and regulating.

Four EIMAC super-power 8973 (X-2170) tetrodes were used to control and protect the four sensitive neutral beam sources in this scientific achievement. The next experiment in this series (PDX) will also utilize EIMAC 8973 tetrodes to control the neutral beam sources. The EIMAC 8973 is also being used at Oak Ridge National Laboratory, another major research facility involved in the Department of Energy's program to develop practical fusion power. The 8973 is a regular production tube designed for high power switching and control by EIMAC division of Varian.

For information

Contact Varian, EIMAC Division, 301 Industrial Way, San Carlos, California 94070. Telephone (415) 592-1221. Or any of the more than 30 Varian Electron Device Group Sales Offices throughout the world.
Kitbuilding is easy and fun for the whole family... send for your new FREE HEATHKIT CATALOG TODAY.

ALL THAT'S NEW IN THE WORLD OF KITS

Nearly 400 fun-to-build money-saving electronic kits your family will enjoy for years to come.

Send me my FREE Heathkit Catalog. I am not currently receiving your catalogs.